[illegible] MENTOR Books of Interest

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HEREDITY, RACE
AND
SOCIETY

L. C. Dunn and
Th. Dobzhansky

Revised and Enlarged Edition

A MENTOR BOOK
Published by THE NEW AMERICAN LIBRARY

ONE WORLD—*Many Men*

One of the m[illegible] important [illegible] is that they [illegible] must live [illegible] differing individuals [illegible] are to adjust ourselves [illegible] we must understand what [illegible] differences [illegible] how they [illegible] how lasting [illegible] likely [illegible] of them [illegible] group [illegible] differences [illegible] only [illegible] and [illegible] education [illegible]

In th[illegible] second [illegible] and exp[illegible] important [illegible] D[illegible] D. b[illegible] Blanky [illegible] single [illegible] external [illegible] describe the [illegible] They [illegible] practical [illegible] likely to increase [illegible] or [illegible] tomorrow.

Other [illegible]

[illegible] theory [illegible] ex[illegible] been added to this edition.

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1 Hum[illegible] D[illegible] 18

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Controlling M[illegible]

[illegible] Rac[illegible]

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1 Human Differences

[illegible]

[illegible]

[illegible]

Hitle I cliesed that the Aryan Nordic German race vs the only one endowed vith a t ltitude of excellent ju lities and vith no l d o es B it do not cre lit Hitle vith having invented nat onal self glorif cation since time immemorial people everywhere have indulged in tl Cons ler for ex iple the fo lowing excerpts from the ep tle dd e ed i 7 3 l y E peror Chien Lung of Ch i to K g Ce ge III of Bi tain i re ponse to the l tters em b ssy pre p ng com nerci l rel tions be tween tl e two countrie

You O King live b yond the confines of many seas i e ertheless impelle l by yo r hu nble desire to j rtake of tl e be efts of our c lisp atched a n i ion respectfi lly rial If you assert that you Celestial Dynasty fills you with a civ l t o i our ceremo es nd code of laws d ffer so on pletely fron your o n that e f your Envoy ere b e to acq ure the i l nent of our c l at on v o ld not po s bly tr n j lar t o r manner nd c t s t your l n so l If I l e co n l d that the trib te offerin se it by you O Kin are to be cepte l th v as ((lely in co i deration for the spirit which pr mpted y t t lesp t h them fro i far Our Dy stys j ti tue l j enetr ite l into every c untry ler H av i n l ki s of ill t tio h ve ffere l t c co tly tr lute l y l d ar l e As yo A b al r c see fo h i elf e j e ll thi et io v e o i obj t sti n e o m en or a d have no use for your country s manufactures

Do this sound ridiculous? No iore so tl n the n u cl atter l y Br tl ers l A ner ca about tl e u p rio ity of A lo Saxon lizatio over tl e Uncl ig g F st Mu h effo t l been e pe ded to j ro e tl p o ty of tl e o lle l No l ra e of No tl we tern 1 t j g i rally of o rse l y No l

Ol l Americ i

This sort of conceit is not confined to p ingressive n t ons A l e i tif il work of an M xican m o lern j nter has inscr bed in it Throug l y t e v ill sj eak the Sp r t The may never have heard about the nomadic Kirgh z l ing in the mountains and deserts of A n But one of us heard a gray bearded p triarch expoun l ng the conviction that the of tl e Ki ghizian is si perior to that of any oth r And the heart is what really matters in men th an a r of fr l ty

The belief that the d fferences betv een men

training wh ch they receive Both extreme wrong since it s known that many human tr s the characte of our bloo l l etl er we e bl nd or not the color of ot r eye and m ny tra ts are inborn—tl ey are determined very l h redity v hile m n y others in luding tl e d se et the language we sj eak the religion we pro determined not by here lity b t by where pened to be born l y our environ nent A n tl i gl t vill l ow us tl t l et ee so calle l y and so-c lled environ ie ital traits there j l i l an l f st l ne Both l ere l ty and environ n of course l e invol ed i i the o m of every l characteristic But our b lief concerning which o has a decisive inf uence on sj ec f c differences w termine o r ct ons reg irding tl em

Democ acy and Rac sm

Se e l ol tions of tl e p ol l of l i ia i h

nental an l cultu l liffe n o g te i mi t

be considered superficial and relatively quite unimpor[illegible]lacks were clearly innate. Although certain of the Latin
[illegible] Christianity and other great religions [illegible] white—French, Spanish and Italian—whose blood had
[illegible] (no matter what they practiced) [illegible] been polluted by mixing with unworthy lower races
[illegible] mankind is one great family in which brotherhood were bound to decay. This theory of innate differences
would ultimately prevail [illegible] by which groups of men could be classified into su
An application of the above teachings to practical [illegible]perior and inferior races found ready support particu
[illegible] which [illegible] larly in Germany, where it was expounded [illegible]
[illegible] by the [illegible] Houston Ch[illegible]
[illegible] berlain whose writings underlie the race myths of the
[illegible] the Nazis. There was even a good scientist, Max Muller
[illegible] unlucky [illegible] used the word Aryan race to
[illegible] Democratic society should [illegible] to describe peoples who spoke a certain group of languages
[illegible] Muller soon recognized his mistake, for difference in
[illegible] political, social and economic arrangements [illegible] speech need not have anything to do with biological
[illegible] But while this mistake died early in
[illegible] politics, and thus there arose truly
[illegible] an imaginary creature, Aryan Man
[illegible] democracy would take [illegible] of human [illegible] which became one of the Nazi gods
diversity and in fact preserve the unlikenesses [illegible] It wasn't long before the Aryan and Nordic race
To many people the religious and democratic solutions [illegible]ories found support in England and America. In
[illegible] however impractical or [illegible] this country we had such books as Madison Grant's
[illegible] that all men are not [illegible] ability or in [illegible]ing of the Great Race and Lothrop Stoddard's
capacity to develop the characters which are regarded Rising Tide of Color to warn us that the Melting Pot
[illegible] No [illegible] humanness are [illegible] about to ruin beyond repair the American breed of
[illegible] than Scare propaganda of this sort became widespread
they are not [illegible] and perhaps should not [illegible] gained some influence on public opinion especially
[illegible] equality [illegible] either [illegible] in the decades preceding and following the First World
[illegible] War. It probably had political repercussions in the
[illegible] the enactment of the immigration [illegible] in the ten
The fate of every individual according to this [illegible] ascendance of isolation in the U.S.A. A strong
[illegible] very largely fixed by the Dice of Destiny [illegible] popular revulsion against racism set in however when
[illegible] hereditary equipment. Hitler came to power in Germany and used the alleged
The doctrine of inherent inequality of men has been [illegible] superiority of the Nordic race and similar notions to
[illegible] many think [illegible] Plato [illegible] military aggression and the extermination of
[illegible] Greece. More recently there was the C[illegible] de[illegible] of innocent victims in concentration camps
[illegible] intelligent French noble
[illegible] called *[illegible]entific Study of Human Diversity*
[illegible] the Inequality of Races. To Gobineau the
[illegible] difference between the great Until recently the religious and political solutions of
[illegible] No[illegible] whites, yellows [illegible] the problem of human diversity had not sought

scientific formulation or vindication. Now, however, you hear people say, "There ought to be a scientific solution," or "Science ought to be able to tell us how to live in a world where these human differences keep stirring up conflicts." And indeed attempts have been made to examine scientifically the questions about human differences. Unfortunately many of these attempts [illegible] because scientists, like all other men, often [illegible] to the temptation to prove [illegible] particular [illegible] [illegible] preconceived [illegible] ideas about human [illegible].

Francis Galton, a versatile English scientist who was a younger contemporary and a relative of Darwin, propounded the view that most human differences are innate, due, in his words, to Nature rather than to Nurture. Galton was convinced that the English propertied and governing classes were a repository of virtually all that is biologically precious in the English nation and [illegible] in [illegible]. He wrote: "By natural ability I mean a nature which, when left to itself, will urge [illegible] an inherent stimulus, climb the path that leads to eminence, and has strength to reach the summit—one which, if hindered or thwarted, will fret and strive until the hindrance is overcome, and it is again free to follow its [illegible] living instinct. It is almost a contradiction in terms [illegible] to doubt [illegible] [illegible] will generally become eminent. On the other hand, there is plenty of evidence [illegible] [illegible] that [illegible] high reputation [illegible] [illegible] these [illegible] [illegible]. It follows [illegible] [illegible] [illegible] [illegible] [illegible] identical [illegible] [illegible] [illegible] [illegible] not impede men [illegible] high ability from becoming eminent [illegible] I shall now [illegible] [illegible] [illegible] competent [illegible] [illegible] [illegible] ability."

[illegible] different from Galton's [illegible] the view of [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] to [illegible] the [illegible] [illegible] which would [illegible] [illegible] [illegible] [illegible] [illegible] once the

have been selected chiefly on the basis of predatory rather than truly constructive behavior. The respectable captain of industry, military leader or politician and the successful gangster are psychologically not so far apart. The high-minded, the scrupulous, the idealistic, the generous, and those who are too intelligent to wish to confine their interests to their personal monetary success, these are apt to be left behind in the present [illegible] battle.

Galton pointed out that it should be possible to improve the human stock in the same way in which farm livestock has been improved, that is, breeding from the best. This would require some social control over human marriage and reproduction, and to the study of such ways of improving the human race Galton gave the name Eugenics, which means being well born. As originally stated by Galton, it was intended to give to the more suitable races or strains of blood a better chance of prevailing speedily over the less suitable than they otherwise would have had. As we have seen, the socially eminent and financially successful are in Galton's view largely identical with the biologically [illegible]. From "the more suitable races" it is not a very far cry to the "great race" or the "master race." In its emphasis on [illegible] [illegible] and its assumption that they are fixed by birth, [illegible] led to deflect attention from [illegible] [illegible] conditions which could be remedied to those for which the only [illegible] to prevent the [illegible] [illegible]. It must be admitted that this is indeed a gentler doctrine than the extermination [illegible] [illegible] (and practiced) by the Nazis. Yet [illegible] interesting fact that in the United States some of the most ardent eugenists were also adherents of the myth of Nordic and white superiority.

The kind of solution proposed by Gobineau and his followers [illegible] [illegible] [illegible] [illegible] races [illegible] [illegible] [illegible] social [illegible] [illegible] and cultural [illegible] [illegible]. The solution [illegible] [illegible] [illegible] that all men should recognize and conform to [illegible] natural hierarchy [illegible] [illegible] [illegible] [illegible] from high

to [illegible] and good to [illegible]. It is not surprising that writers with [illegible] to [illegible] one should have been swayed by prejudice and self interest.

In general solutions to such problems as what to do about inborn differences among men can arise only out of the knowledge and understanding which it is the function of science to provide. Powers over human life such as those required to put a eugenical program into effect can be entrusted only to a society in which social and economic equality of individuals and groups is guaranteed and protected in positive ways. The best protection is the will and knowledge of the people and it is the fundamental obligation of science to equip them with the biological facts necessary for understanding human likenesses and differences. That will be the aim of this little book. We shall try to state the facts of heredity as simply as we can so that those with no previous acquaintance with the subject can understand its basic ideas and appraise some of the evidence upon which the ideas rest. In doing this it will be necessary to explain what heredity is and how it operates when the likenesses and differences of the parents are distributed amongst their children in accordance with definite rules. These rules known as Mendel's laws depend upon the peculiar way in which the sex cells and gametes of man, animals and most plants are formed and combine to produce the offspring and the pertinent facts of sexual reproduction will thus be outlined at the outset.

We then ask the old question: Is it nature or nurture, heredity or environment [illegible] the [illegible] conditions [illegible] the [illegible] is [illegible] for [illegible] differences. [illegible] to [illegible] light on the question. [illegible] of the [illegible] method [illegible] hereditary differences are transmitted [illegible] of course to a subject of major interest [illegible] the individual differences [illegible] large groups [illegible] possible to disc

a purely scientific way such fighting questions as whether race differences are absolute or relative and what the prospects are for the disappearance or increase of racial differences.

We may as well state at the outset that we are not seeking to persuade anyone of the virtue of any type or breed of [illegible] or of any special political or [illegible] or [illegible] society. As biologists we view human differences as facts which call for understanding and interpretation, not as qualities to be either condemned or praised. In fact in describing groups of men in biological terms we do not recognize categories defined as good or bad, superior or inferior. These categories are statements of opinion; to have any meaning as facts they would have to be accompanied by specific statements such as "Most Negroes are superior to most whites in their resistance to malaria." "Most whites are superior to most Negroes in their resistance to tuberculosis." Statements about the superiority of one group over another in native intelligence are usually made from the standpoint and for the purposes of one of the groups under which the other must always be at a disadvantage.

As naturalists we should sound very silly if we were to say "W[illegible] are superior to caterpillars in native intelligence because it's the wasp that stings and lays its eggs in the caterpillar and not the other way round." Statements about relative intelligence may be reached someday as conclusions, but at present they are not useful as [illegible]nation which lead to a better understanding of [illegible] differences. We shall try to confine ourselves to [illegible] whether [illegible] yellow, by Jew or [illegible] Baptist or Cath

2 Nature and Nurture

WHY ARE PEOPLE different one from another? [illegible] Men have been [illegible] this question [illegible] of years and the answers that have been [illegible] boil down to two. First, people are different [illegible] food, climate, upbringing, education, income [illegible] the physical and cultural surroundings—[illegible] people differ because their environments differ. Second, we come from different parents, different families, stocks and races of men [illegible] differ. These two great forces, environment and heredity, form our bodies, minds and characters. Galton long ago called these forces nurture (the conditions of life) and nature (inborn, inherited).

[illegible] spent in argument about the relative importance of nature and nurture. Probably thousands of hours have been used up by [illegible] preparing for debate on "Resolved that Heredity is more important than Environment." Although it would be too harsh to say that these hours have [been] wasted, nevertheless a little thought will show that the question asked in that form is not [illegible]. We cannot take away from any human being heredity or environment. We come into [illegible] the [illegible] to [illegible] nature co[illegible] to the nu[illegible] [illegible] largest [illegible]

u[illegible] and words of wisdom are of no avail without [illegible] to heed and retain them. On the other hand inherited possibilities would never become actualities without the means by which they may grow and develop. Nature and nurture are so obviously necessary and inseparable that the important question is not which is more important but rather how together they determine our qualities.

xual Reproduction

All our heredity, our nature, is transmitted to us from our parents through tiny cells which connect our [illegible] substance with that of our forebears. Each human [illegible] takes its origin from the union of two of these [illegible] of living matter, an egg from the mother which [illegible] been fertilized by a single sperm from the father. [illegible] egg is a tiny sphere hardly visible to the naked [illegible] it has been estimated that twenty million human [illegible] would weigh about one ounce. A sperm is visible [illegible] with the aid of a microscope, and its volume is [illegible] eighty-five thousand times smaller than that of [illegible] egg. Furthermore a sperm is quite different from an [illegible] appearance, being shaped like [illegible] end to form a head. Some idea of the sizes of [illegible] links between the generations has been [illegible] by an eminent American biologist H. J. Muller. [illegible] has calculated that if we could collect together all [illegible] eggs from which the present human population of [illegible] earth has sprung—two billion two hundred millions [illegible]—they would occupy the volume of about two [illegible] half quart. The sperm cells—two billions of them—would occupy the space of half an [illegible] [illegible] equally from both [illegible] other [illegible] equally important [illegible] the male and female sex cells are [illegible] extremely [illegible] size and [illegible] structure as well [illegible] children [illegible] traits? Already in the nineteenth century some

It seems that the only reasonable solution of the paradox is to suppose that it is not the sex cell as a whole but some particular bit of it, alike in both sexes, which is chiefly concerned with heredity. Indeed careful study of the sex cells under strong microscopes showed that one part is similar in eggs and sperms. These similar parts are the nuclei of the sex cells, or more precisely the chromosomes in the nuclei. Each egg and each sperm contains twenty-four chromosomes, which are tiny bodies of living substance which can be stained with certain dyes. A theory was put forward at the turn of the century that heredity is transmitted through the chromosomes. This chromosome theory of heredity has been fully confirmed much further evidence discovered in the present century.

The chromosomes occupy a considerable fraction of the volume of the sperm but only a tiny fraction of the volume of the egg. The combined volumes of the chromosomes in the 00 000 000 sperms and in the equal number of egg cells from which the human beings now living have sprung would add up to less bulk than an aspirin tablet. And yet this minute amount of substance contained the heredity of the whole human race.

The life of an individual is kindled when a sperm fertilizes an egg. Fertilization consists in fusion of the nucleus of the sperm with that of an egg. The fertilized egg proceeds then to divide into two, four, eight, and finally billions of cells which compose the adult body. Each cell receives by division a nucleus identical with that of the fertilized egg. The heredity received from the parents is thus *present in every cell of the child*.

The developing body grows very rapidly at first, then more slowly. An adult body weighs about fi billion times as much as the fertilized egg. Where

d th n from the food which o rselves co ally similar

quite literally the material which is ourselves is derived from the neighborhood grocery store. But food does not become a part of the living body except through a complex process of digestion and assimilation. It is the heredity of the assimilating organism which transforms the nutriment taken from the outside into a likeness of the organism and of its ancestors.

Heredity and Environment

By and large, the materials which enter our bodies are pretty much the same for every human—so much water, so much oxygen, so much mineral, protein, carbohydrate, and other food. This is almost literally true for unborn children, which are nourished by the mother's blood, since human blood has a very constant composition. And yet different heredities transform this same material into different forms and different individuals result. Consider that the environment is roughly the same for brothers and sisters reared in the same household. Nothing is more certain, however, than that brothers and sisters often, perhaps generally, respond in different ways to the same environment. A brother the curly hair that a sister so ardently desires. More he has an allergy to the cats on which the sister dotes; eggs do not agree with her while he wants them twice a day. One hums melodies from babyhood while the other is tone deaf and can not carry a simple tune.

Negroes have been living in the United States almost as long as whites, yet whites and blacks have not, in the common environment, come to resemble each other in color. We know that the lighter color of some people classed as Negroes is due not to nurture or climate but to white ancestors. In Africa similarly white men n their skin color after many generations of resi

that nature

transform

and different

features into

ration will

[illegible] that all that such a statement means is that if an environment is at all suitable for human life a baby either grows to be a man or does not live at all. What we really want to know is how different could individuals with similar heredities become in different environments, and how great are the differences which individuals with different heredities may be expected to display in the same environment.

The skin colors in Negroes and whites differ doubtless by nature. But observe the skin colors of enthusiastic bathers on beaches in California or Florida, or for that matter near New York in late summer. Some are as dark as Negroes, or at least as mulattoes. Yet many of these dark-skinned fellows become quite pale after spending a long winter in a city apartment. Such changes in the skin color are evidently due to environment, not to heredity. The upshot is, however, that, strange as it may seem, a black and a white [illegible] some [illegible] have very nearly the same skin colors. The statement that Negroes and whites differ in skin color proves to be inaccurate, or at least incomplete. We really [illegible] say that they differ in the skin color in some environments but not in others. It would be even better [illegible] people called white there are some [illegible] who do not develop much color in the skin [illegible] of [illegible] to sunlight, others who have little [illegible] without exposure but a strong color [illegible] exposed to sunlight, and finally some whose [illegible] more or less swarthy [illegible] without sunlight. Negroes have dark skins in all known environments.

[illegible] Heredity?

When you hear it said of somebody that he has in- [illegible] you know [illegible] of the statement that [illegible] for [illegible]

his disposition from his mother. Biological heredity is transmitted through sex cells which have no eyes in them and no definable disposition. It is not the eye color or other traits that are inherited but something within the sex cells which determines how a living individual will react to various environments. In some families children are born who in spite of adequate feeding and care never grow to be tall. Members of other families grow tall and strong with little care. These facts do not contradict the opinion of medical authorities that nutrition, exercise and health conditions influence the growth and physical development of children. We can say that stature is inherited; it is more accurate to say that the stature depends upon heredity as well as environment. Each heredity responds to each environment by producing a certain stature.

Some people can not retain and utilize sugars which they get in their food; instead the sugars are expelled in the urine. These people are diabetics, and this disease is hereditary. About two decades ago it was discovered that injections of a drug called insulin relieve promptly the attacks of diabetes. The injections do not cure the illness [illegible] and the attacks recur unless injections are made at proper intervals. If given regular injections a diabetic may lead a normal and happy existence. A normal body prepares its own insulin. The heredity of a diabetic makes his body incapable of preparing insulin, but if insulin is supplied from outside the acute disorder called diabetes fails to appear. You may not suspect that your friend has a diabetic heredity if he creates for himself an artificial environment containing insulin.

Heredity Is Not Destiny

Some people speak and write about heredity as though it were something like destiny, the decision of which can not be appealed. Such a hopeless and [illegible]

[illegible] is not necessary if we realize that [illegible] the responses of the person to [illegible] and not the presence or absence of [illegible] as such. We cannot change the heredity with which we were born, but in at least some cases we can [illegible] an environment to which our heredity will re[illegible] most favorably. Those who like dark skin color take sun baths or apply the color out of a bottle. The [illegible] White ladies with straight hair [illegible] permanently waved, and Negro [illegible] straightened. To be sure, no ointments, drugs, or other treatments are known for many hereditary [illegible]. They [illegible] be [illegible] covered in the future, even as the [illegible] treatment of diabetes has recently been discovered.

[illegible] certainly does not solve the nature-nurture [illegible]. The fact remains that there are many different [illegible] ments, many different heredities, and that people differ from one another in many ways. We want to [illegible] to what extent the observed differences between [illegible] are due to the existing variety of environments [illegible] heredities. We ought to be able to recognize as environmental those differences which appear when [illegible] of the same heredity are exposed to different [illegible] ments. Unfortunately it is not easy to find people [illegible] the same heredity. We know that even members of [illegible] family [illegible] differ from each [illegible] [illegible] the [illegible] [illegible] especially in the [illegible] ctions [illegible] to us. For ex[illegible] [illegible] by gla[illegible] [illegible]

[illegible] to [illegible] [illegible] to [illegible]

[illegible] and the other left in the valley. The two [illegible] different condition[illegible] [illegible] ber of leaves, length of stems and roots which come to distinguish these plants may thus be traced directly to specified environmental conditions. Such knowledge is very useful and would be especially important for human beings.

Twins

In humans, obviously, it is not possible to make experiments of this kind deliberately, but luckily such experiments happen once in a while by accident. These experiments happen [illegible] [illegible] rth out [illegible] accidents are called identical twins. [illegible] In a great [illegible] of about each 87 more than one [illegible] rely there [illegible] majority of these cases two babies are born [illegible] births) [illegible] three, that is triplets (about one in 7[illegible] [illegible] and still more rarely, there come four (about one in [illegible] (3[illegible] 000 births). Quintuplets and sextuplets are extremely rare, but not so rare as is popularly believed, since some sixty cases of quintuplets are recorded and even six cases of sextuplets.

Of the twins born, about one quarter are identical. [illegible] it is easy to understand why these are so [illegible] and useful for [illegible] Ordinary twins [illegible] merely [illegible] who happen to be born at the same time. They come from two separate eggs and show the [illegible] differences [illegible] ordinary brothers and sisters. [illegible] of the plant [illegible] fertilized egg by some accident gets split [illegible] each part [illegible] grows into a [illegible] to [illegible] them [illegible]

This should help us to assess the part played by environment in producing differences among humans.

Identical twins had attracted the attention of laymen as well as of biologists before their manner of origin was known, just because they are so nearly identical in appearance. They are always of the same sex, same complexion, eye color, hair form and blood type, and are similar in height and build. They tend to make similar records at school and to resemble each other mentally and physically as well. Yet [illegible] of course [illegible] similarity in their environment [illegible] usually [illegible] ordinary twins, the two-egg variety, like [illegible] and often are quite unlike. [illegible] about half of the cases they are of opposite sexes [illegible] one may be blond, the other brunet, one tall, the other short, etc. These characters are hereditary, and environmental similarity does not extinguish differences between them. We can therefore conclude that the similarity of identical twins is due to their identical heredity as well as to like environment.

As one-egg twins grow older some differences between them begin to appear. One may gain [illegible] the other [illegible] more easily develop [illegible] or other [illegible] from the other [illegible] respect [illegible] often be [illegible] the [illegible] other organs (which rarely happen) the eye [illegible] We begin to see [illegible] differences [illegible] could by study [illegible] one-egg twins [illegible] influence of [illegible] and environment upon particular characters [illegible] possible when one-egg twins are separated [illegible] adopted by families [illegible] under different

conditions. This is the nearest approach possible in man to the ideal experiment in which a single individual is divided into two parts each of which is transplanted to a different environment.

One-egg twins reared apart have been studied by several scientists beginning with Galton in the nineteenth century, but it remained for the team of H. H. Newman (a biologist), F. N. Freeman (a psychologist) and K. J. Holzinger (a statistician) of the University of Chicago to make the most thorough-going study of such twins. After some fifteen years of work they found and studied twenty pairs of one-egg twins of which the members had been separated in infancy. For comparison they studied fifty pairs of one-egg twins which had been reared together and fifty pairs of two-egg (but same sexed) twins reared together. From comparison of members of all of these twin pairs in physical and mental traits they sought to discover first to what extent and in what traits the members of one-egg pairs were more alike than the members of two-egg pairs and second—to what extent and in what traits the differences in one-egg twins were increased when their environments [illegible] Similar studies have been made by a [illegible]

important respects.

Physical Traits in Twins

Newman, Freeman and Holzinger made careful measurements and observations on a variety of physical characters (height, [illegible] fingerprints, etc.) and mental [illegible] They [illegible] them to a [illegible] the intelligence [illegible] test [illegible] A part of their [illegible] the following table which gives the average differences between the twins of a pair in [illegible]

AVERAGE DIFFERENCES BETWEEN MEMBERS OF TWIN PAIRS

	[illegible]	[illegible]	[illegible]
Standing height [illegible]	1 6	1 8	4 1
[illegible]	1 0	3 3	10 0
[illegible]	[illegible]		[illegible]
[illegible]		8	1
[illegible] Quotient			
[illegible]	3	8	9 9
[illegible]	[illegible]	[illegible]	1 6

[illegible] they were reared together or apart [illegible] body height [illegible] The [illegible] difference in height [illegible] the one-egg twins reared together and [illegible] 8 [illegible] were reared apart. The two [illegible] both [illegible] together differed [illegible] [illegible]

[illegible]

[illegible] more than do twins reared together, it is the environment which is responsible. We can see that different traits are influenced to different extents by heredity and by environment. In physical features such as eye and hair color, head shape, or height, one-egg twins remained extremely similar even when separated at birth and brought up in different environments. But one-egg twins may become rather different in weight. Environment can modify the weight of a person relatively more easily than it can modify his height or his head shape. But it does not follow that heredity has nothing to do with one's weight. Surely you know persons who find it difficult to keep their weight down despite keeping themselves on reducing diets, and other persons who cannot gain much weight even on fattening foods.

[illegible] among the separated one-egg twins [illegible] A girl of sixteen named Edith [illegible] by a young man: Hello, Fay, how do you happen to be so far from home? Suspecting an attempt at flirtation, Edith rebuffed the young man. But he was a persistent young man who trusted his memory for faces, so in another city he found the real Fay and arranged for her to go [illegible] Edith [illegible] as she said, [illegible] to see myself getting off the train. [illegible] proved to be one-egg twins [illegible] at birth [illegible]

[illegible]

The [illegible] to the story of [illegible] twin brothers, both of whom became during World War II generals in the U.S. Air Force. Although they had not served in the same military units and had made their careers independently. Can one conclude from this instance that the hereditary endowment of these men was responsible for their [illegible] achievements in the [illegible] field of activity? [illegible] is quite [illegible] it is possible [illegible] other of some

[illegible] still serves as a surgeon or [illegible] he has [illegible] tured of [illegible] life altogether.

Newman, Freeman and Holzinger compared the [illegible] abilities of twins by means of various intelligence tests. On one of these IQ tests (Binet's) the average difference between one-egg twins reared together amounted to [illegible] points, but when they were reared apart the difference increased to 8 [illegible] points. [illegible] twins reared together [illegible] average [illegible] [illegible] influenced by heredity [illegible] to modification by environment than [illegible] traits. In different achievement tests [illegible] measuring educational performance the role of environment proved to be greater still. The Stanford Achievement test showed the average difference between one-egg twins reared apart to be even greater than that between two-egg twins reared together. In spelling the [illegible] were more alike than the two-egg ones [illegible] environment was much more important. In tests of motor ability and emotional balance environment assumed the major role; more than half the difference between twins being due to experience [illegible] and other environmental factors and less [illegible] half to heredity.

It must [illegible] pointed out that the [illegible] of [illegible] twins studied by Newman [illegible] were not very different. [illegible] exposed to the same education [illegible]. We [illegible] twin might [illegible] of the [illegible] of the other [illegible] surroundings [illegible] effort [illegible] if one were to [illegible] American [illegible] and the other [illegible] be [illegible] Asiatic [illegible] the differences in living conditions [illegible] more marked [illegible] personality [illegible] tests [illegible] the twins [illegible] examined [illegible] likely [illegible]

Studies of other investigators have shown that such important behavior traits as criminality are to some extent influenced by heredity. For example, prisons were combed for members of twin pairs. Where the twins were of the one-egg type, then in many cases the other twin was found to be also in prison or had a criminal record. Where the pair was of the two-egg type the [illegible]jority of the cotwins had not been convicted of any [illegible] of the investigators, Johannes [illegible] Crime as Destiny. If this [illegible] exclusively determined [illegible] fallacy. The facts justify [illegible] by heredity the conclusion [illegible] at most the conclusion that, given a certain environment, persons of some hereditary constitutions are more likely than others to fall into antisocial behavior.

Foster Children

The dependence of mental traits on both heredity and environment can also be demonstrated by studies on foster children. When children are distributed to foster homes it is unavoidable that some of them will be placed in more and others in less favorable environments. [illegible] then compare the intelligence and [illegible] different [illegible] children who [illegible] interesting [illegible] Suppose for the [illegible] children [illegible] intelligence of a group [illegible] environment. The [illegible] determined [illegible] environment [illegible] proportional to [illegible] of foster children [illegible] of the [illegible] families. If on the contrary intelligence were due to heredity alone there would be no consistent relationship between the intelligence test scores of foster and of own children. The actual situation is intermediate between the extremes. [illegible] foster children show higher IQ's in homes in [illegible] own children have higher IQ [illegible] and vice versa. [illegible] points to the importance of the environment. But [illegible] not the whole story. In the most favorable foster

) f t r l ill en average I s i an perform ance th n n hille n th l s fn ell rles f ter Ir n l o th contrary n average pe f rmance r rt cvnd ller Thi sl s the p e c c f a Je e l t e t r t m th devel pment f the qt h I l d IQ t t t c re

j the result of stu l s on twin l on f r h l lren l not l ent prove th t l re l ty is tant th n environment as often cl l Ir th c tt le l ov th t there is r ot j t one l t l e l ty and environment l t t ny l ve to this quest o n ep rately about e l j l I rent lt nt Thi s n field of study wh h t f tu e heult l l s such P h p t will h lp t r e th current v s about th Nature Nur tt r j l em to employ an allegory wh ch however t not be t l ed too f r or taken too l ter lly I the f t on of ea l hum n trait there s k d of ock s n nent b t een th l orn Nature d t r u d Nurtur N t j le gr at v r y k d N rt re r ary l lle e t key I l t w l f lo k r l l ll esp l l I r f key S c l k d t t p r t I t y k y p r v lcl l y th ex t g ty t l l s s r cer ent l lcf ct t f r k t l f dv c l e l t l t t ly f w r d l t s l l l n t r j r d t y t c t t n t h ch ha l been tr ed It t ok a rewly c c key n l n to f t th t peculiar lock The o k mn l behavior n re ulated is in s ne s t th t t l es not e ly yield to th c o d ry K s e t l l y pos rty l f t e c l cat o d ur un l g l t t th r p s th t l lo k open v th ny one f the e k ys th t l er l ty determin s only responses to t b t t the p c e e er l enc of g c v l r v l e c l o r th t ted t s t th o l y f v t f l c t t v l l p t l s l t ce r t l t l the r to cre te

c n v i r n n v h h th t l t nce r or nb ent n ents It is true that f r m ny l ere l t e no r n cents l a e been fo m l as yet l ch w ll cha ge th re pon e l p r t l y The here l ity v h l determ n s o r eye c l l l l g r o p tyl r f p r p r t typ seen to pre lic th me t at n l k r v c vit r ter l ll k r lor t t re nd weight r p t ert ly l ere l t ry b t they are al o en t v t en t r t l ychic ch r cte s such a cr min lity re so sen it e to er vironment th at th e very l ct th t l r dity l nyth ng t ll to lo with them v l t g n d p t Ir h l l a g en trait belongs d p e d how e r o l w h ch v e know abo t th e tra t m quest on as th x t p le f d l ete l r ult s lov

On the whole mo le n b lo gy l strengthened the l ds of those who try to mp o e the m nd d bodie f men by m prov ng th e con lit ons n wh l they live l l e t o l nent l a d en t o nal Nat r e are very r l s e to Nurt e of el c t on t l oc l nfl n s l l e pers al ty s fl e ced by el c tion m l r t l g o l l t t t l t l on t an l m l r l t ors l t c p t l l y t r gl o p r t e

I l l d t l Cult l D t t j H l

l e t l ty

Our intellect re e t l l l l l a ol o r ly influenced by el n t t l l y l g cont t t th t some v r t l do bted or e en denie l ot r l t that biological e l ity l s a ny n ll ence wh t e r o the develop t t of l n p rsonality To n y people the ex tence of h r t ble differences p ychic tra ts e ms t c n p t t le th le ocrat c r l l t t r th t tho c l o h t w th hol l certa n l t s d opport t es fro on grou p of the r l l w h ve y often l t to j t t fy the r att t l l y Ilc c l l t l l t t y f th l o t v l l like to k p t l l t t t t t r t o n of l ll e l t t t t l x t ly because it th p l ty of r l t l t t l

[illegible] permits [illegible] to be together [illegible] to pr[illegible] a co[illegible] [illegible] tion [illegible] the role [illegible] ality in the [illegible] of [illegible] per[illegible] [illegible]

[illegible] doubt that certain [illegible] conditions [illegible] and the nervous system represent the re[illegible] of [illegible] heredity. Some of the mental dis[illegible] tend to run [illegible] and some forms of idiocy [illegible] a [illegible] inheritance [illegible] of one [illegible] disturbance of one of the [illegible] the body [illegible] namely the [illegible] of a chemical [illegible] own [illegible] is present in norm[illegible] [illegible] bodily [illegible] excretion [illegible] the urine. This form of mental [illegible] development [illegible] Of [illegible] be [illegible]

[illegible] or other [illegible] We do not know yet whether [illegible] [illegible] and sets of [illegible] caused by physical factors which [illegible] to [illegible]

res[illegible] In consequence [illegible] may be uncertain [illegible] his action and his [illegible] personality may be set by [illegible]

Not only [illegible] traits as well [illegible] influence [illegible] ality [illegible] youth [illegible] the prevalent notion of beauty [illegible] excessively [illegible] lad with unattractive facial features. Other things being equal the former is more likely to be popular with his companions of either sex than the latter. No [illegible] of [illegible] in the [illegible] of one's man[illegible] one [illegible] world outlook is co[illegible] On the other hand he[illegible] redity is doubtless an important factor [illegible] the deter[illegible] [illegible] of the body build and the facial features (which is not to deny the importance of the environment in the development of the e[illegible] as well!)

A Negro or even [illegible] person [illegible] swarthy skin will probably [illegible] the company of [illegible] namely the [illegible] color. [illegible] appear does [illegible] take any [illegible] point that a trait which [illegible] not hereditary [illegible] trait [illegible] modified by the environment [illegible] personality [illegible] the framework of certain [illegible] cultural setting [illegible] framework [illegible]

[illegible] only [illegible] call [illegible] It [illegible] great [illegible] highly important [illegible] influ[illegible] [illegible] It [illegible] and cultural [illegible] is ment first of all our [illegible] the framework [illegible] care for [illegible] ation [illegible] other human [illegible] right. Further [illegible] pattern of behavior of [illegible] and of [illegible] [illegible] completely for granted that we notice the very [illegible] of these patterns only [illegible] [illegible] have [illegible] [illegible] any of [illegible] other people the pattern of clothes [illegible] [illegible] eat [illegible] [illegible] have [illegible] for a great body of [illegible] [illegible] country [illegible] [illegible] different people [illegible] [illegible] foundly [illegible] by the [illegible] or deteriorate [illegible] [illegible] of [illegible] of the

[illegible] to [illegible] ages [illegible] spoken by the [illegible] [illegible]

nese ho[illegible] a [illegible] to be culturally Chinese [illegible] [illegible] other [illegible] [illegible] important [illegible] to [illegible] American [illegible] [illegible] of [illegible] of the [illegible] the American [illegible] [illegible] tants from foreign countries [illegible] development [illegible] like other American children and sometimes come to resemble in outlook and behavior native Americans more than their own parents. These children have not more than their own [illegible] [illegible] their parents and more [illegible] the tran[illegible] [illegible] for centuries to certain [illegible] by [illegible] [illegible] American cult[illegible] [illegible] [illegible]

It is important to remember that such cultural ac[illegible] over long periods of time [illegible] even when acting over long periods of time [illegible] become biologically inherited. The question is part [illegible] the so-called [illegible] of acquired characters, which is discussed later in this book. At [illegible] only point out that no good [illegible] the source of [illegible] occur [illegible] [illegible] [illegible] We can take it that acquired characters are not inherited.

Many great discoveries in science [illegible] have often [illegible] to [illegible] Certain [illegible] everything [illegible] [illegible] in persons [illegible] [illegible] cultures [illegible] of little con[illegible] biological heredity [illegible] [illegible] consequence. Certain [illegible] those be[illegible] [illegible] is to study and [illegible] different cultures [illegible] [illegible] created [illegible] [illegible] of [illegible] [illegible]

[illegible] they [illegible] Heredity [illegible] [illegible]

[illegible] Heredity [illegible] opera[illegible] [illegible]

3 The Method of Heredity

WHEN [illegible] HAVE [illegible] real understanding of some [illegible] ginary natural processes they are apt [illegible] origin [illegible] The ancient Greeks did not know [illegible] They pictured the sun as [illegible] a beautiful god Apollo [illegible] across the [illegible] bright chariot drawn by seven tireless horses [illegible] mythology [illegible] poetic [illegible] philosophy [illegible] attempt to [illegible] All [illegible] mythology [illegible] dangerous to confuse mythology [illegible]

The fact that [illegible] had to be [illegible] and so generally [illegible] knowledge [illegible] into the general [illegible] beliefs. Blood [illegible] fertile [illegible] sprinkled [illegible] the bravery [illegible] blood before [illegible] whose blood [illegible] possible [illegible] of the [illegible] the blood [illegible]

Heredity Th[illegible] Blood

Blood does of course perform important functions but the transmission of heredity is not one of them. F[illegible] two centuries it has been known that the child [illegible] not from the blood but from the union of two tiny cells from the parents—a single egg cell from the mother with one sperm cell from the father. But even today the old myth persists and some people speak as if blood were the carrier of heredity. In [illegible] lan[illegible] it is common to hear such expressions as [illegible] blood [illegible] half blood [illegible] mixed [illegible] All this usage expressed merely [illegible] of precision characteristic of everyday speech [illegible] would result. But the situation is more [illegible] than that for [illegible] people continue to [illegible] of heredity [illegible] by blood they will [illegible] understand not only the [illegible] nature [illegible] but [illegible] of the problem [illegible] well as [illegible] heredity plays [illegible]

Heredity is [illegible] children to resemble their parents and other [illegible] closely. The [illegible] and the parent [illegible] ever [illegible] like. One parent may be blond and the other [illegible] tall and the other short. It is clearly part of the problem of heredity to [illegible] these [illegible] the children [illegible] will find that [illegible] children [illegible] parent [illegible] between [illegible] and [illegible] ([illegible]) [illegible] color [illegible] that the father [illegible] the [illegible] of the child [illegible] occur [illegible] blood [illegible] the child which [illegible]

[illegible] which [illegible] came from one of the grandparents or [illegible] ancestors. For example some blue-eyed children are born in families in which both parents are brown- or black-eyed but in [illegible] other ancestor or relative had blue eyes. In such [illegible] we say that the blue-eyed trait [illegible] skipped a generation. But how can blood skip a generation and how can brown-eyed blood make children blue-eyed?

Another common fact which flatly contradicts the blood theory is that brothers and sisters though show[illegible] a certain family resemblance are clearly different from one another. One may be brown-eyed and another blue-eyed; one may have normal vision and another be color-blind. It is well known that brothers may belong to different blood groups so that one may not be able to give blood for transfusion to the other. Such facts clearly mean that each child (with the exception of identical twins) receives from its parents a unique heredity different in some way or ways from the heredity passed on by the same parents to other children of the same family. How could the same parents [illegible] different blood to each of their children? Now that we know the actual [illegible] by which we inherit from our parents it seems strange that [illegible] should ever have taken stock in the blood theory but a great scientist as Darwin did and so did many others of his era and before Great discoveries [illegible] simple [illegible] they have been made and the [illegible] they [illegible] then [illegible] proper [illegible] until the great [illegible] the proper [illegible] come together [illegible] the [illegible]

Mendel's Discovery

The discovery of the method of heredity is one of the [illegible] history of science. It oc[illegible] a great [illegible] part of Czecho[illegible] Moravia [illegible]

[illegible] There a monk named Gregor Mendel worked patiently and methodically from 1857 to 1865, crossing different varieties of the garden pea and studying the differences through several generations. In 1865 he read an account of his experiments to the society of naturalists in the town of Brno (Brünn) and this was published in the journal of the society in 1866. The journal did not have a wide circulation although it was sent to a number of libraries in several countries. Many scientists read it, but they paid no attention to it. For thirty [illegible] ed the gist of the modern theory of [illegible] world. This was the origin of the science [illegible] which [illegible] in 190[illegible] [illegible]

[illegible] of heredity [illegible] one [illegible] by Mendel [illegible] universal application to all forms of life. The fact that they were discovered through experimentation on [illegible] vegetable, the garden pea, was due to Mendel's deliberate choice of this plant as offering special [illegible] for the objective he had in mind. [illegible] that for [illegible] he must study the [illegible] Moreover he must know the exact parentage of [illegible] and this meant that all [illegible] completely [illegible] by the experimenter. [illegible]

[illegible] make the conditions [illegible] experimenter [illegible] of society. nor [illegible] men and women choose their mates because [illegible] has blue eyes [illegible] of group AB while the other has brown eyes [illegible] of blood group O. People [illegible] rather than the [illegible] controlled ex-periment on heredity cannot be used as a method of study on human beings. Large domestic animals, cattle, horses, or sheep are also unfavorable because of low fertility, slow breeding, and great expense of raising large numbers. The need to observe thousands of individuals of known parentage sometimes through dozens of generations has led students of heredity since Mendel's time to choose for experiments the rapidly breeding vinegar fly (Drosophila), Indian corn, mice and rats, wheat, snapdragon, poultry, tobacco plants, and more recently molds and other microorganisms. Enough [illegible] learned about the heredity of particular traits [illegible] to make it clear that Mendel's principles apply to [illegible]

Mendel's Law

The essence of Mendel's discovery lay in his identification of the units of heredity. These units, the genes, were the first living units to be discovered which are comparable to the atoms or molecules upon which our understanding of the non-living world has been based. The discovery of them has had a fructifying effect upon the whole of biology comparable to the effect of the atomic theory upon the physical sciences.

How can one apprehend such living units which cannot be seen? In particular how can one prove them to be discrete, durable particles endowed with the kind of finality which molecules have? Mendel first recognized genes from the manner in which specific visible characters of plants, such for example as flower color, reappeared in their offspring. His method was so simple that it can be repeated by anyone who can observe the results of controlled mating in any kind of animal or plant. When a plant of a pure purple flowered variety of peas was crossed with a white flowered plant, the seeds produced always yielded only purple flowered plants. When these purple flowered plants were allowed to produce their progeny, these were found to consist of two kinds of plants with respect to flower color: about $\frac{3}{4}$ of

i e purple flow r nd 1/4 h v white flower W n s e l from th e plant the grandchil h n of the r ri l purple flo er d and white flowered plants was n e l it v a found r i t th ugh the grand hildren r I tv v ly different ty l they con isted f c ffer it types in re p ct to their l ility to trar n t he c l t uy d f rences n flower Ior Of ll of th n c l ld e r vere like the purple gr nd arent purple to ll th ir ff I i g 1/2 w re l k u ents tr i mitting purple to some of their t to others v h le 1/4 vere like the white al ic t tra t ttr white only to ll their off Actu lly in o ie f Mendel e p rim nts the l dren consisted of 70 purple to wh te c c f l lant (d ut 3 1) while of 100 f th e pur t te tce t l on v purple offspring C p h l l oth ple white c l ut i Thus the whole en consisted of about 1/4 pure purple 1/2 hybrid l l white Since white n t e p l r the l N c l l called it recessive n trast t th t p which is expresse l i the hybrid

l i ll ty v th v l l th s ratio ppe red n ll f N l expe ents and in tho of other wh o c d l experiments on other k l l of p nts and l le t certa n th t s ry r t l r l f t l t ned th c l f th l l l n l l y f l l l e purpl or l t It w ery I tl l o e r le y to e of p l c of l l l l p rpl s le nd a l te side (or r l d a l t l) Anyo c wh o l tr ed ch c t k ow that i l t 1/4 of the to se both o s l I he d le i p i 1/2 of the tosses one is c d d re t l h le in the rem ning 1/4 both e l Mendel s v th t the fund nental ular ty be t c i the c n nl the pl nt must be th t purple or e fl r c or must dep nl e the sam k nd of v t il t l term e the f ll f con It m t b l th t c n l ppen in o ly c f two l ff

c

ice of th the ry h prop r l v th t t

lik flower color are tran itted l y r t of units in the sex cells One of th se un ts c n l p rple or whit r e er a mixture From a p t c p rple p nent only pur p l unit are tran n tted fro n v l te r e only white t r t but a hybrid th t is a pl t who p rents were c l l lferent colors ich l l l l l l hite or e in equ l two kin l of units p rpl r c l hite or e in eq l ii ibers Wh n th e t o k r d f n l ge n u r l re fert lize l ly the t k n l l l llen ther l lt con l n to as of p l l th l l l purpl w th l te white w th purple nd wh te v th h te Th l te white w th p u ple d wh te v th h te The l ast into f r the type de elop i to purpl plan t the last into hite plants h nce the r t 1/4 l ke one gr nd p rent hite plants h nce the r t 1/4 like one gr nd parent (pure purple) 1/2 like the p re t (hybrid purple) 1/4 like the other gr nd parent (pure white) which is the fund mental

Oft n this r tio of 1/4 1/2 1/4 which is th e f nd mental c n ll heredity i direc tly o servable Thu n t c n ll heredity i dir ctly cl rvabl Thu t c of Blue Andal si n f l reg rly pr luce offspring of Blue And l si n f l reg l rly pr luce off pring c l h l 1/4 re l l k 1/2 re l lue an l 1/4 are white In tl it i b r l l th t l l e r th e n me of l y l t l form which t un t t l l l Th s ve y l l y i i tin bl k l r l ll wh t o Only blue f l l y r itin bl k l r l tl vh t o On ly blue r th Mendel s un ptions l t the u its of he ed ty c n be s nply ill st ated i th s c by s ppo ing th t c n be simply illustrated in th s c by supposing th t l tl l r f l l l c l rd l l t w ll tr i mit black (B) l l ll vl t (b) l t i l ly l r tl l l f l c l l l v y vh l tl l l l v

			1/2 B		1/2 b
eggs	1/2 B	1/4 BB (black)		1/4 Bb (blue)
	1/2 b	1/4 bb (bl)		1/4 bb (white)

l l l l l l l to the pr lu t r f about BB l l l l ll l l to the pr h t i f about BB bb (white) o it (l l k l k t) o Bb (bl e) l l bb (white) o it (l l kcl ker) o Bl (l c) l l (bl ck kers) o Bb (blue) o t 1/4 l l k 1/2 blu 1/4 l hl nl l o t lo t 1/4 l l k 1/2 blu 1/4 l te hich i j t vh t the l ltry b eders (and th l te h ch i j t vh t th l ltry b ders (an l tl

b l st) found This is ex t th t Mendel di co c l in every cross that he m de bet een his different of peas Alway the mating bet een t o hybrids (or of hybrid mating with itself by self-fertilization) produced offspring of which about ¼ were like one grandparental typ ½ were like the hybrid parent and ¼ were like the other grandparental type This s known as the Mendelian segregation ratio of 1 1 to Mendel that it prov d th the ry t each of the sex cell of a hybrid could transmit or and only e f the contrasted parental charact r nd that half of the sex cells t tran it one of the characters nd l transmit the alte n t e ne l ery as t p c of lternative conditions of one unit wh l er t o r ju r d n f ct the proof of the existence t them elve an l this was the revolutionary c introduced by Mendel

Mendel found that this theory held true for every r f character which he studied in the pea plant t been confirmed by experiment with hun e l of other k of an l l plant In all cases be n shown that the g n cont buted to the l d l the parent do not mix but re egregated the different s ell of the hybrid so that the f l l l character f the parent will reap t o t m tel y t p s e th l t hybrid v of he dity d l by Mendel kn f c t o

I (

He per t n of the l v of seg egat on n t l l ply t c ll char ter like all n j o t t nily Al no j on l ck p ment n (l l lite) k (e light) n l yes wh k the p k l l th l l c l the l k l e W l r c l w l t c l l t n s ll hl the t t t l t t l l t l l n ll l ly l y ll l

lly le fo l M f f milies in which are albino both parents are albino ll the l l are albino The e f cts and others how that albinism is recessive nd that the normal parent of albino children are hybrid (heterozygot) If we denote the unit for l n ly a and its counterpart p e t in normally mented people then e d cribe these parent A and expect that of their children about ¼ will be A and about ¾ or together ¾ normal) and about ¼ about ¼ aa (or to ether ¾ normal) and about ¼ (albino) In various w y it has b en shown th the expectation is realized If you are normally pigmented and have an albino brother or sister you can e ene as about t your chance carrying albino gene as about out of 3 becau e of the norm l such families would be Aa nd your chances of not carrying an albino gene t out of 3 bec use ⅓ the normal in such famil should be AA These chances are proved to be about right by studying the offspring of brother and sisters of albinos

In general light eye color (blue) behaves as recessive to dark eye color (black or brown) but it is not as easy to separate people t two sharp l e for eye color s for ll ll green gray and flecked eye ke trouble for the cl f But th care and tion t be l th M l l w of g g t ll hes to the eye l r d to any other r l t t l to y l n l ch ra t lite

We mention l e l th e t l t o kind of s v th c l l l ty t te p l ylthi b nde (PTC) th t o nd c t te this substance The ability to taste PTC t like any other Mendelian character To h t e l p t l ke any other M l l character To etermine th o t the offspring o from n ces t l h the r parent can taste PTC l ch are parents ter nd the other l l l t l l lly l l both parents r t bl l S l l t at t t perfo ned l y t t bl l S l total of chil ll ke l ee In fa illies with total of el l l el l l l l th ll l th e el l he

[illegible] families in which both [illegible] children were tasters and [illegible] families in which one parent [illegible] taster and the other was a taste-blind [illegible] half the total children [illegible] taste-blind. The ability to taste PTC is due to a dominant gene which we may call T [illegible] ability to taste PTC [illegible] one [illegible] A taste-blind person is always pure for (tt) since if he carried even one T he would necessarily be a taster. If both father and mother are taste-blind, all the children are taste-blind. A taster may be [illegible] hybrid (heterozygous) Tt or pure (homozygous) TT. If both parents are tasters and [illegible] is one [illegible] is pure TT all the children will be tasters [illegible] true if [illegible] TT [illegible] But if both parents [illegible] hybrid (Tt) [illegible] expect among their children [illegible] from [illegible] taste-blind [illegible] person [illegible] half [illegible] the [illegible] have been [illegible] of [illegible]

[illegible] al Genes

[illegible] the [illegible] the [illegible] the [illegible] the [illegible] the [illegible] Mendel [illegible] children [illegible] the [illegible] characters [illegible]

[illegible] only in families in which at least one [illegible]

ordinary fingers and [illegible] in about equal numbers just [illegible] short and ordinary [illegible] as Mendel found in his test cross of a hybrid to a recessive. This means that virtually all short-fingered persons are hybrid (heterozygous) and for the same reason persons with other rare dominant defects are nearly always hybrid and transmit the defect to about half of their children. Sometimes, however, the abnormal gene occurs in an isolated village or valley where people are likely to marry neighbors and relatives and then it may happen that two with the same abnormality marry. A case of this sort was recorded by two Norwegian investigators who found a family in which both father and mother had the short-fingered trait. Two children were [illegible] other had the short-fingered [illegible] the other was a cripple [illegible] short-fingered [illegible] the other [illegible] so ab[illegible] with [illegible] fingers or toes [illegible] it did not live very long [illegible] for the short-fingered character getting [illegible] but the handi[illegible] gene from both father and mother [illegible] probably never [illegible] so severe that such a child [illegible] probably [illegible] live to adulthood. We should therefore not expect to [illegible] is pure (homozygous) for such an [illegible] bo[illegible] ty

Combinations of Genes

In the [illegible] Mendel did [illegible] and have picked out one pair of characters for study [illegible] neglecting all the many other characters [illegible] Mendel had to face the [illegible] always differ. Eventually Mendel [illegible] of following more than one [illegible] at a [illegible] of following more than one [illegible] pairs of characters [illegible] and discovering how different pairs of characters [illegible] to each other. What would [illegible] to ex[illegible] dwarf? By [illegible] Mendel [illegible] the law of [illegible] other [illegible]

independent assortment. Mendel found that where double hybrids were bred together all possible combinations occurred in the offspring by pure chance. That is, in the second generation from the cross of yellow round by green wrinkled the color of the seed was quite independent of the seed shape. Of the yellows, 3/4 were round and 1/4 were wrinkled, and of the 1/4 of greens, 3/4 were round and 1/4 were wrinkled. In other words, 3/4 of [illegible] or 9/16 were yellow round, [illegible] of [illegible] or 3/16 were yellow wrinkled, 3/4 of 1/4 or [illegible] were green round, and 1/4 of 1/4 or 1/16 were green wrinkled. Describing each seed in these two ways at once, Mendel counted the following actual numbers in the experiment and compared them with ideal numbers expected from the proportions given above.

	Actual number of seed	Expected proportion	Ideal number
[illegible] round	315		313
[illegible] wrinkled	101	[illegible]/16	104
[illegible] round	108	[illegible]/16	104
[illegible] wrinkled	32	1/16	35
Total	556		556

The actual figures are so close to the ideal that they can be taken to represent the proportions given [illegible] Mendel [illegible] traits [illegible] green [illegible] wrinkled [illegible] inherited [illegible] are independent of each other.

This independence in inheritance of separate traits of plants, animals and men was an entirely new idea, which Mendel was the first to recognize and to prove. It has many important and interesting consequences. [illegible] in Mendel's crosses [illegible] of peas, one [illegible] yellow round and [illegible] wrinkled [illegible] generation [illegible] [illegible] called [illegible] [illegible] [illegible] [illegible] [illegible] which [illegible] greatly [illegible]

[illegible]sed. This is of great importance in practical agriculture. Suppose that you have two varieties of a crop or vegetable plant and that each variety possesses an advantageous trait which the other does not have. For example, one variety may yield well but may not have sufficient resistance to frost, while the other is frost resistant but produces unsatisfactory yield. It is obviously desirable to have a combination of good yield and frost resistance in the same plants. If yield and resistance are chiefly influenced by two pairs of independent genes, then according to Mendel's second law this may often be accomplished by crossing the two varieties and selecting in the second generation of hybrids the plants which possess the desired combination of traits. Plants which have the undesirable qualities of the initial varieties combined will also appear among the hybrids, making a careful examination of individual plants and of their progenies essential. Many of the best varieties of [illegible] have been arrived at by combining [illegible] plants [illegible] the traits which [illegible] were present separately [illegible] older [illegible]

Causes of Variety

Independent inheritance greatly increases the number [illegible] Mendel showed [illegible] of different kinds of [illegible] three and [illegible] two [illegible] plant [illegible] yellow round [illegible] different characters [illegible] wrinkled [illegible] purple flowers [illegible] white flowers, the [illegible] of a cross [illegible] these varieties were of eight different types [illegible] each of the four combinations of yellow round, green [illegible] wrinkled could be either purple or white, which [illegible] In fact every [illegible] of combination [illegible] different [illegible] of combi[illegible] differences [illegible] If [illegible] only [illegible] (3) (1) [illegible] ( ) [illegible] eye [illegible] about [illegible] the [illegible] As anyone can tell by looking about him the

number of human character differences is much greater than three so the number of combinations must be very large

The following table shows the number of types which theoretically must appear among the hybrids when the parents differ in a certain number of dominant genes

Gene differences	Types [illegible] progeny
1	2
	4
	8
4	16
5	32
10	1 024
[illegible]0	1 048 [illegible]76
[illegible]0	1 07[illegible] [illegible]1 8[illegible]4
n	[illegible]

The number of distinct types (gene combinations) [illegible] to [illegible] than a thousand when parents differ in [illegible] genes to more than a million with 20 and to more than a billion with 30 gene differences With 31 gene differences it becomes about equal to the total number of human now living in the world which is estimated close to [illegible]00 millions With still greater numbers of gene differences the numbers of possible gene combinations become immense With about [illegible]0 genes the number of theoretically possible gene combinations is of the same order as that of the electrons and protons the universe as estimated by some physicists

S[illegible] calculations may seem meaningless because [illegible] certa[illegible] than th[illegible] only an ex[illegible]

[illegible] t

calc[illegible] [illegible] ers [illegible] o [illegible]

[illegible] e that [illegible] hybrid [illegible] ten [illegible] is [illegible] y co[illegible] [illegible]ive estimate [illegible] the figure probably greater Now such a

hybrid produces 1 024 distinct types of sex cells and is capable of engendering that many different types of offspring We see then that the chance of two brothers or sisters receiving the same hereditary endowment from their father or from their mother is small The chance that they receive the same endowment from both parents is quite negligible unless of course the brothers are identical twins As we now know identical twins arise from a single egg and have the same genes

How many genes there are in man is unknown but it would seem reasonable to believe that man has at least as many as the [illegible] fly Drosophila To be sure the number of genes is not precisely known even in that insect which has been studied more than any other animal but it [illegible] estimated that a Drosophila has several thousand perhaps as many as ten thousand genes in each sex cell

To [illegible] the difficulty of counting the genes in any animal or plant [illegible] the method through which we learn about the existence of the gene in the first place Mendel observed the segregation of the purple and white flower color in the offspring of a hybrid between the purple and white varieties and concluded that the pea plant must have a gene for flower color Our knowledge of the genes for tasting PTC for eye color for albinism and for brachydactyly in man come from observations on the distribution of tasters and non tasters brown and blue eyes albino and [illegible] short and [illegible] fingers in selected human pedigrees But imagine [illegible] that all the peas existing in the world or known to us are purple (or all white) or that PTC has never been [illegible] The existence of the genes for the flower color in peas and for tasting PTC in man would not even be suspected In other words we find out about the existence of a gene for [illegible] g[illegible] trait only if we observe [illegible] which differ with respect to that trait and [illegible] only if such individuals [illegible] segregation in their [illegible] all traits in [illegible] spring [illegible]

[illegible] have been observed to vary in different individuals. The [illegible] of the total number of genes in that insect has been arrived at by very different indirect methods which we need not discuss here.

We have seen that hereditary differences between brothers and sisters can easily be accounted for if the parents are hybrid for several genes. Brothers, sisters, and relatives in general tend, however, to show family resemblances; the differences between [illegible] relatives are on the whole greater than between relatives. If [illegible] Drosophila [illegible] human [illegible] carry several thousand genes [illegible] that only about three hundred of these genes are [illegible] at least two alternative conditions, such as *A* and *a*, dominant and recessive. This is [illegible] only [illegible] for the purpose of [illegible] we are going to [illegible] understate [illegible] to an overestimate. Three hundred genes [illegible] are capable of producing a [illegible] number of combinations—more than there are electrons and protons in the Universe. Although we cannot as yet [illegible] an exact count of human genes, we can be very [illegible] that all the gene combinations which exist in all the humans [illegible] in the world constitute just a [illegible] small fraction of gene combinations that could be formed.

[illegible]

We [illegible] tell [illegible] kind is [illegible] most [illegible] great collection of types [illegible] which exist [illegible] existed in the past [illegible] that any human [illegible] set of genes is practically [illegible] twins excepted. The heredity [illegible] each [illegible] not [illegible] existed in the past [illegible] certainly

not repeatable in the future. A biologist must assert the absolute uniqueness of every human individual. This same assertion translated into metaphysical and political terms is fundamental for both ethics and democracy.

A father and a mother transmit different sets of genes to each of their children. A human sex cell has one gene of each of the kinds which we have discussed (for eye color, taste reaction to PTC, albinism versus normal, brachydactyly versus normal fingers) [illegible] coloration [illegible] any other genes [illegible] of course [illegible] We estimate that [illegible] human species must [illegible] the full [illegible] by a [illegible] dual [illegible] each

Since the body gets [illegible] of each kind. If there [illegible] it follows that [illegible] are five thousand different genes in the egg and five thousand in the sperm cell, there will be five thousand pairs or ten thousand altogether in every cell composing the body of the individual. However, when sex cells, whether eggs or sperms, are formed in that individual's body, there is an exact biological mechanism [illegible] egg or sperm will receive one [illegible]

[illegible] the next child [illegible] which each parent [illegible] will [illegible] 1/ of the genes [illegible] different set of genes [illegible] but it will [illegible] as we know [illegible] for every child.

An analogy may be helpful [illegible] understanding clearly the workings of the heredity mechanism. The [illegible] genes present in [illegible] sex cell may be likened to a suit [illegible] several cards except that [illegible] Suppose that [illegible] instead of the thirteen cards [illegible] the maternal cards are red and the [illegible] red and [illegible] black one. No [illegible] child has two [illegible] when the child grows up and produces its own sex [illegible] for each cell. But [illegible] cell [illegible] or only black [illegible] it does not matter whether only red or only black

[illegible] cards go [illegible] the outstanding [illegible] cell. One cell may [illegible], for example, [illegible] ten of diamonds, king [illegible] of spades, while another cell may carry [illegible] jack of diamonds and [illegible] ten of spades; a third may carry all diamonds, etc. We may carry this analogy still further. Suppose that the [illegible] of one of the parents consists of diamonds and spades, and the hand of the other of hearts and [illegible] (these now represent the grandparental [illegible]). The role of the [illegible] that a parent [illegible] to the child [illegible] (i.e. [illegible] king, one [illegible] etc.) to make a complete hand [illegible] the cards [illegible] from two of each [illegible] parent [illegible]. The hand which is dealt to the child is therefore contributed to equally by both parents, and each parent contributes one half of the hand [illegible]. What [illegible] will [illegible]? [illegible] But each kind of [illegible] represented only in [illegible] other [illegible] only. So the [illegible] hand [illegible] of diamonds [illegible] diamonds and hearts [illegible] spades [illegible] hearts [illegible] genes from only two [illegible] of the grandparents.

[illegible]

[illegible] ¼ of [illegible] grandchild [illegible] of [illegible] genes of [illegible]

less than that of a grand slam in bridge. But different grandchildren (who are brothers or sisters among themselves) will be likely to inherit somewhat different sets of genes from each of their grandparents. Each of the great grandparents contribute on the average ⅛ of the genes of each of the great grandchildren. Here again variations will occur. A great grandparent may contribute either more (up to 1/[illegible]) or less than ⅛ (down to none). What proportion of the genes of a grandparent or a remoter ancestor will survive in his descendants will depend entirely on chance and in no way on the ancestor's bodily strength or weakness, virtues or sins.

According to the refuted "blood" theory of heredity we inherit 1/[illegible] of our hereditary endowment from each parent, ¼ from each grandparent, ⅛ from each great grandparent, etc. This idea has taken such firm root not only in the popular imagination but even in biology that one [illegible] still hears and reads of a person having ¼, ⅛, or some other fraction of "blood" of a particular race or individual. The most cherished pride of many people is the supposed fact that some fraction of their "blood" is derived from a noble ancestor, or from a passenger on the Mayflower, or from a real or a trumped-up great man or woman. We can see how preposterous such claims are. To be sure, an individual receives on the average ¼ of his genes from each grandparent, ⅛ from each great-grandparent, etc. But [illegible] only [illegible] ality one [illegible] genes [illegible] especially [illegible] ancestors. More important still, all the qualities of our ancestors were not necessarily due to their genes. And even if they [illegible] may have been a particularly lucky combination of genes. Such a combination is quite unlikely to remain intact in the heredity [illegible] for many generations, because the [illegible] heredity is to produce recombinations of the different genes which are so numerous that they are unlikely to repeat [illegible] writers have failed [illegible] themselves into [illegible]

[illegible] believing that they have [illegible] explained the greatness of [illegible] only finding that it is in [illegible] biological [illegible] persisted in his blood by transmission from some particular ancestor.

[illegible] hearing of Mendel's proof that the heredity we receive from our parents consists not of blood but of distinct [illegible] entities, the genes, which pass through [illegible] sperm into the new individual, and that many [illegible] are entirely independent of each [illegible] inheritance people [illegible] And then just [illegible] of several thousand chara[illegible] [illegible]ld be [illegible] The [illegible] sensible comment if we have only the facts [illegible] before us. The fact [illegible] not solely re[illegible] body [illegible] Anyone who [illegible] complexity of any [illegible] body [illegible] the particular [illegible] eye [illegible] like the difference between [illegible] its nerve and blood supply [illegible] material [illegible] eye color could be [illegible] of genes which [illegible] interact with each other [illegible] eye color.

W[illegible]ite In[illegible]

A clear example of the dependence of what seem to be simple [illegible] skin color in the offspring of marriages b[illegible] Negro [illegible] white [illegible] the black [illegible] white. Consid[illegible] [illegible]

mulattoes are very variable from light through intermediate shades to black. Attempts to analyze the inheritance of skin color in Mendelian terms have not been very successful because white and Negro each include a number of different skin colors and many other factors such as tanning and bleaching also affect skin color. But there is little doubt that at least two and probably several gene differences are concerned. In certain matings of mulattoes about ⅟16 of the children are white or close to it, as though two independent recessive factors had come together. In other matings the proportion of whites is lower and the number of gene differences probably higher.

The number of gene differences between the races entering the cross is important because it determines how often individuals resembling the parent races will appear in the second and later generations after a cross. We have seen that if Negroes and whites differ in only two genes for skin color, only one child in sixteen will have black skin and one in sixteen will have a white skin in the offspring of mulatto marriages. With three genes showing [illegible] the chance of a white-skinned child would drop to one in sixty-four, with four genes to one in 256, with n genes to one in 4ⁿ. In marriages of mulattoes with whites the chances of birth of children with white skin are much higher, one in [illegible] with two genes, one in 8 with three, one in [illegible] with n genes.

One of the [illegible] of the so-called race problem in the United States is that anyone who [illegible] ancestry is classed as a Negro, [illegible] one African ancestry [illegible]. A Negro is then, regardless of his [illegible] appearance, [illegible] member of a social and economic group rather than of a purely biological one. Some of the children born to such Negroes are indistinguishable from, and [illegible] anti-Negro [illegible] among the whites in order to avoid [illegible] frequently [illegible] discrimination [illegible] parent of mixed European [illegible] children will be [illegible] to account [illegible] African [illegible] character [illegible] inhabitants of [illegible] African [illegible]

[illegible] as in hair form, thickness of lips, and the extent [illegible]. The inheritance of these differences has unfortunately not been worked out in detail [illegible] known that most of the [illegible] about [illegible] complex [illegible] furthermore the [illegible] which [illegible] inherited independently [illegible] Negroes [illegible] will be [illegible] down be[illegible] would not tell us much anyway [illegible] able to say that if only the few [illegible] taken into account [illegible] very [illegible] If so the [illegible] individual [illegible] distinguishable from white [illegible] offspring [illegible] mulatto [illegible] (one [illegible] 6/77 [illegible] then [illegible] the [illegible] of the parents [illegible] white [illegible] the [illegible] first [illegible] genes will appear in [illegible] among [illegible] or [illegible] The [illegible] are [illegible] of [illegible] to practical problems of the United States [illegible] What they really [illegible] is the [illegible] probability [illegible] child [illegible] from [illegible] Negro [illegible] relatively [illegible] any one of the [illegible] individual of exclusively [illegible] Neither of these two [illegible] White [illegible] the [illegible] population of the [illegible] States [illegible] the population of [illegible] Euro[illegible] with [illegible] with straight, wavy, and curly hair [illegible] of the [illegible] the Negro [illegible] not [illegible] to [illegible] mulatto [illegible] to white [illegible] of the [illegible] skin [illegible]

genes which an individual [illegible] It [illegible] reason [illegible] can not po[illegible] individual with white skin can not possibly harbor these genes [illegible] Negro ancestry [illegible] whether or not he has [illegible] remote Negro ancestry [illegible] with a [illegible] Of [illegible] this work both [illegible] skin [illegible] black skin can not carry [illegible] gen[illegible] white children [illegible] albin[illegible]) [illegible] The occurrence of white [illegible] not be born to Negro parents. The occurrence of white [illegible] Negro children in mulatto families in no way con[illegible]tradicts this.

Summary

[illegible] the reader look [illegible]

[illegible] Heredity [illegible] on [illegible] genes which con[illegible] just [illegible] We [illegible] our par[illegible] [illegible] or [illegible] according to the [illegible] Mendel [illegible] The [illegible]

[illegible] to explain [illegible] the importance of gen[illegible] of persons look [illegible] between [illegible] common [illegible] because they have one of their [illegible] in common [illegible] which differ [illegible] differ in some [illegible] qualities of [illegible] genes. Most genes [illegible] but some [illegible] of all human [illegible] variety which is [illegible] and to recombination [illegible] due to gene [illegible] history of [illegible] these processes [illegible] occurring today. The [illegible] of such processes [illegible] in the next [illegible] chapter.

4 Man as a Product of Evolution

UNDERSTANDING MAN and his place in the universe is perhaps the central problem of all science. The year 1859 [illegible] then [illegible] red-letter date in the history of thought, for in that year Charles Darwin published his theory of evolution which [illegible] only biology [illegible] world outlook [illegible] man. Darwin [illegible] of [illegible] taking [illegible] of the [illegible] evolutionary [illegible] on [illegible] evol[illegible] [illegible]

[illegible] of Darwin [illegible] to [illegible] of nature [illegible] of [illegible]

[illegible] not only of a remote [illegible] as well. A better [illegible]

Natural Selection

Darwin supposed that evolution [illegible] is a consequence of the process by which organisms become adapted to different environments. This adaptation is brought about by a mechanism which he called natural selection. Every species of animal and plant contains some individuals which by their heredity are better fitted than their fellows to survive and to leave a large progeny. Some tigers are more expert than others at catching prey, and some prey are more expert than others at escaping from tigers. The tigers that catch more prey and the prey that escape most often will live longer and have more offspring than those which go hungry or get eaten. As time goes on, tigers will become more and more expert [illegible] their different [illegible] their heredity [illegible] progressively [illegible] better fitness of each species to its particular way of life.

[illegible] upon in the [illegible] to repeat the general [illegible] theory [illegible] studies of heredity [illegible] important additions [illegible] The most important is the [illegible] that heredity is transmitted not through [illegible] but through [illegible] the genes. The processes of gene segregation [illegible] continually generate [illegible] natural selection [illegible]

[illegible] lar environment are perpetuated in the descendants and eventually become established as the [illegible] condition of that race or species. The less fit combinations of genes gradually [illegible] through the failure to leave [illegible] progeny [illegible] them [illegible] The supply of new variants is kept up by the process of mutation, which [illegible] set forth below, occasionally changes old genes into new ones. The number of new combinations of genes which thereby become possible is practically unlimited, and there is [illegible] no limit to evolution [illegible]

Social Darwinism

In science, as in other fields of human thought, progress is often [illegible] continuous [illegible] Darwin, while biologists were so preoccupied with studies on evolution that they did not look [illegible] the [illegible] confines [illegible] strong [illegible] of others [illegible] political [illegible] which is sometimes referred to as [illegible] Darwinism [illegible] people [illegible] Darwin [illegible] hence the grim [illegible] that Darwinism [illegible] theory of hatred and inhumanity. Social Darwin [illegible] follower to [illegible] theory [illegible] Others [illegible] they [illegible] some subtle [illegible] been rejected.

Thus Herbert Spencer [illegible] the expression [illegible] fittest [illegible] the essential principle of Darwin's theory [illegible] expressed better [illegible] [illegible]

universal [illegible] ly in progress [illegible] self! As one [illegible] author [illegible] it was a cheerful [illegible] that no good thing was ever lost and no lost thing was any longer [illegible] of the real as well.

Applications to human problems were bound to come [illegible] of the [illegible] Darwin [illegible] Francis Galton, the founder of the eugenics movement, was a relative and follower of Darwin. Many authors further [illegible] scientific biology than Galton [illegible] blood [illegible] engender [illegible] do so in human [illegible] nothing else but [illegible] of nature. So the [illegible] Superman created by the German philosopher Nietzsche became promptly identified with the surviving fittest [illegible] and the early twentieth centuries [illegible] were built [illegible] colonial empires it was comforting to think that [illegible] slogan [illegible] inferior stocks [illegible] were simply [illegible] one. The same [illegible] replaced by biology [illegible] the Superman [illegible] when he said [illegible] Hitler was [illegible] nations [illegible] mankind [illegible] physically [illegible] eternal peace. To be [illegible] likely to be killed [illegible] atrocities [illegible]

Here [illegible] the strong [illegible] ically and [illegible] the weaker [illegible] as between nations [illegible] application to [illegible] One simply [illegible] inferior classes [illegible] The consequences [illegible]

[illegible] fied that the existing inequalities place everybody [illegible] he biologically belongs. Both the liberals and the conservatives are sure that [illegible] of social inequalities would result in biological disaster [illegible] view with alarm [illegible] biologically subversive trend toward [illegible] its progressive taxation, free education, social security, and other coddling of the supposed carriers [illegible] genes. Only few go to the length of urging [illegible] be withheld from the poor [illegible] medical help from those afflicted with hereditary disease. But many [illegible] that the coddling [illegible] only if supplemented by measures such as [illegible] which would [illegible] biological harm done by our [illegible] to follow the [illegible] of the jungle.

To some people [illegible] are so dear that they are prepared to [illegible] the weak should [illegible] [illegible] well. However [illegible] existence [illegible] the [illegible] strife as the [illegible] biological survival.

[illegible]

[illegible] of the jungle [illegible] Biologists know that [illegible] cooperation [illegible] nature [illegible] Surely [illegible] other [illegible] the other. We know [illegible] kill [illegible] But [illegible]

no appreciable harm but may even [illegible] useful by man[illegible] turing some of the vitamins needed by the human [illegible] Some animals and plants have become so com[illegible]

[illegible] between [illegible] so widespread in both animal and plant kingdoms that a special word, *symbiosis*, living together, has been coined for it.

It is a plausible though not fully confirmed hypothesis that parasites which seriously incapacitate or kill their hosts have only recently (on an evolutionary time [illegible]) on that species. Consider that [illegible] parasites [illegible] to the [illegible] with its [illegible] organisms are [illegible] or [illegible] the forces of survival [illegible] to minimize [illegible] process of evolution [illegible] ally adjusted [illegible] cooperation and [illegible] part of nature. [illegible] of culture [illegible] conception and the [illegible] significance [illegible] error [illegible] as well as [illegible] It is [illegible] ape with [illegible]

[illegible]

[illegible] evolution without reference to his culture is only matched by the disregard of biology by [illegible] of some psychologists and sociologists.

The human species has evolved an adaptive mechanism [illegible] in its power and effectiveness has no precedent in all the billion years of living evolution. Th[illegible] the human brain. Animals and plants [illegible] adapted to their environment [illegible] changes in their bodily structures and functions. Man attains mastery of his environments chiefly through discovery and invention. It is thanks to the activities of his brain and [illegible] the preservation and [illegible] of these activities [illegible] they are [illegible] — [illegible] that he [illegible] able [illegible] to this [illegible] make [illegible] conquest of the earth. As [illegible] species [illegible] has proved to be a remarkably [illegible] natural selection [illegible] strength [illegible]

What then are the properties which make man biologically fit? The answer is clear [illegible] fitness [illegible] with [illegible] the [illegible] men [illegible] Th[illegible] [illegible] some [illegible] submission [illegible] [illegible] perfectly [illegible] persons is superf[illegible] [illegible] tion [illegible] cts [illegible]

[illegible] however that there is no basis for such an assumption even for organisms below man in the evolutionary [illegible]

Bad Genes

The qualities which natural selection favors or discriminates against depend upon the environment in which the animal or plant lives. What is "bad" for the individual in one place, for example a tropical forest, may be "good" in another, such as the Arctic or a desert. The [illegible] man are in part of course [illegible] the [illegible] qualities [illegible] value in his [illegible] physiological adaptations [illegible] ancestors and those [illegible] such as resistance to specific diseases which permit him to survive in a variety of habitats. There are other qualities however which [illegible] does [illegible] environments are [illegible] qualities, and first and foremost among these are qualities of brain and sense organs. A powerful brain and a great spirit may sometimes reside in a weak body, and we all know of great men who were invalids for much of their lives. To say this is not to deny the importance of bodily strength and health. The ideal is certainly a sound brain in a sound body; *mens sana in corpore sano* has been [illegible]

It [illegible] evolution. Quite [illegible] the present [illegible] of human evolution [illegible] effects of bad [illegible] from the [illegible] environment and inadequate nutrition which are the [illegible] of a large proportion of the world population, there [illegible] particular genes and combinations of genes which [illegible] all human environment. This there [illegible] by a child [illegible] one form of [illegible] The world [illegible] both parents [illegible] found does not begin to exist [illegible] infant with this [illegible] does [illegible] to speak unless [illegible] anyone [illegible] speech [illegible]

child because both of them [illegible] in fact carry a recessive gene for [illegible]

Many people are blind because they inherited particular genes. An appreciable proportion of the many blind persons in the United States are victims of defective genes. Not all of these have the same gene for blindness. Indeed, over a hundred different hereditary eye [illegible] are known, some dominant, others recessive.

Probably all organs of the body are subject to defects brought about by specific genes. There is one [illegible] one which makes the [illegible] brittle [illegible] that slight [illegible] produce fractures. There is another which [illegible] able to study [illegible] and many [illegible] genes [illegible] different minor malformations [illegible] Still others [illegible] the [illegible] and defects in heart [illegible] blood and in mental [illegible] bodily functions.

[illegible] the [illegible] two [illegible] of the [illegible] doubtfully [illegible] There is one gene, a recessive, which when received from both parents gives rise to a form of [illegible] idiocy [illegible] blindness [illegible] seems normal at birth, but a loss of vision and mental deterioration occurs at the age of about five to six months. Complete [illegible] and idiocy are soon reached [illegible] death [illegible] usually [illegible]

[illegible]

[illegible] of the body by which proteins [illegible] broken [illegible] the preceding case [illegible] although [illegible] never [illegible] have children.

[illegible] frequency of [illegible] kept [illegible]

very many such genes which [illegible] the aggregate effect is considerable [illegible] mental deficiency so that the [illegible]

Genes responsible for mental illnesses which manifest themselves after the age of reproduction has been [illegible] would not be held in check by early death. Unfortunately little is known about the mode of inheritance of the different mental disorders [illegible] genes [illegible] recognize that many of the genes responsible may express themselves only under particular conditions of [illegible] stress. Some authorities [illegible]

[illegible]

the [illegible] es. It [illegible] certain [illegible] mental deficiency due to bad genes. Epilepsy, for [illegible] probably [illegible] often [illegible] injury or [illegible] disease than by a defective gene. There are [illegible] by genes which produce defects in most of the [illegible] which we have thus far been able to provide.

To be contrasted with these bad genes are those hundreds of different useful ones, most of [illegible]

[illegible] which [illegible]

[illegible] success shows that [illegible]

Some authorities believe that the possessors of [illegible] the genes are now reproducing more rapidly than [illegible] the possessors of [illegible] that [illegible] a biological [illegible] which [illegible] the opposite of that expected from natural selection [illegible] the reversal of natural selection [illegible] better nutrition [illegible] human [illegible] Modern [illegible] hygiene [illegible] the life of [illegible]

[illegible] off under natural conditions, meaning by natur[al] [illegible] the living conditions of sav[age]s or of animals. Human kindness and the desire to help the unhappy and the weak lead to the universal [illegible] propagation of defec[tive] [illegible] genes. Th[ese] arguments appear so plausible and the problem [illegible] so grave that an intelligent pe[rson] must g[ive] them some thought. This is doubly true because these arguments are exploited by those who would like to withhold the benefits of modern sc[ience] [illegible] [illegible] pretext of [illegible] nature to [illegible] selection the [illegible] powers of the masses for poverty.

Ge[illegible] M[illegible]el[illegible] P[illegible]lations

Where does the great variety of bad genes come from? Has the hereditary endowment of mankind really been [illegible] deteriorated? To consider [illegible] answers to the question we must understand how genes change by mutation (p[illegible]) how particular forms of genes [illegible] through populations [illegible] that the genes that [illegible] human populations [illegible] remain [illegible] people [illegible] to [illegible]. The [illegible] problem was taken up [illegible] simultaneously by H[illegible]y [illegible] English [illegible] by Weinberg [illegible] C[illegible] [illegible] ry of M[illegible] [illegible] of the [illegible] population.

[illegible] the [illegible] way to study the behavior of human [illegible] populations would be [illegible] think [illegible] numbers of genes of [illegible] kind ([illegible]ally [illegible] that kind of [illegible]) with known [illegible] of genes [illegible] the kind [illegible] after [illegible] several generations [illegible] Collection [illegible] of the [illegible] Such [illegible] the [illegible] [illegible] of this [illegible] for

Even were such an experiment possible, it would defeat [its] ends, for if there were a prefe[re]nce for blonds or for brunets (as there often is) mating would hardly be at random, and there would be little scope for the genes to distribute themselves by chance. Moreover, blond [illegible] and black skin do not differ by just one pair of genes, and counting [illegible] all the intermediate shades of skin color from black through khaki and caf[illegible] to more or less white would be troublesome and [illegible]

These diff[illegible] could be [illegible] gene difference [illegible] character which [illegible] and therefore [illegible] this character [illegible] selection. We have already [illegible] influence [illegible] in Chapter [illegible] About thirty [illegible] kno[illegible] [illegible]ty per cent [illegible] gene *T* for tasting and [illegible] There [illegible] gene [illegible] Now [illegible] people have [illegible] for taste blindness. Now [illegible] know [illegible] ever heard of PTC [illegible] or [illegible] not taste it. [illegible] whether a particular girl [illegible] or [illegible] not taste it would not influence the [illegible] even though he knew [illegible] would not [illegible] marry her. Under such [illegible] with which he ought to marry [illegible] conditions we can be [illegible] PTC [illegible] large [illegible] now [illegible] population [illegible] per cent [illegible] three or [illegible] generations? [illegible] population [illegible] by the [illegible] investigator [illegible] character [illegible] per cent [illegible] of [illegible] United States [illegible] time [illegible] understand [illegible] the [illegible] [illegible] pendix [illegible]

is that no matter what may be the proportions of tasters and non-tasters in the population of an island or country, these proportions will persist indefinitely. Of course this is true not only for the genes *T* and *t* which are responsible for the ability or inability to taste PTC, but for any other genes as well, provided only that persons who do and who do not carry these genes live [illegible] and have on the average the same number of children. The genes found commonly in a population today will remain just as common centuries later, and rare genes will continue rare. Contrary to what the names dominance and recessiveness seem to imply, the dominant genes do not crowd out the recessive ones, nor do the recessive genes crowd out the dominants. The frequencies of the genes tend to remain constant.

The Gene Pool

We can consider the genes of all the inhabitants of [illegible] country, continent, or of the whole world [illegible] a pool of genes. The people [illegible] the bodily endowments of the population [illegible] traits of the world. The [illegible] kind of the [illegible] is only [illegible] of the pool of genes [illegible] to [illegible] PTC [illegible] [illegible] sanity [illegible] different [illegible] all [illegible] pool [illegible] gene with a certain frequency.

As shown in the Appendix, it is easy to calculate the frequency of a gene in the gene pool of a population if [illegible] frequent [illegible] that population are [illegible] [illegible] show the gene. For example, in the United States [illegible] per cent of the population ([illegible] of the whole) are non-tasters of PTC [illegible] recessive gene [illegible] the gene pool [illegible] of the population

of persons showing the effects of that gene. Since non-tasting is recessive to tasting, the proportion of the gene for non-tasting in the gene pool is the square root of [illegible] per cent ($\sqrt{} = 0.55$) of all [illegible] per cent or about [illegible] per cent. It is equally easy to find the [illegible] genes of the [illegible] kind. It [illegible] who will show [illegible] proportion of persons in a population who will show the effects of a gene if we know the frequency of that gene in the gene pool. The frequency of persons showing the effects of a recessive gene is the square of the frequency of the gene. For example, if a recessive gene [illegible] per cent or 0.0[illegible] [illegible] ¹⁄₁₀ [illegible] per cent ([illegible] = 0.001) of the whole) [illegible] per cent ([illegible] [illegible] population [illegible] show its effects.

We can then predict with confidence that the present proportions of blue-eyed and brown-eyed persons in New York City will be found in New York some centuries hence unless one or more of the following things happen:

(1) Relatively more blue-eyed (or brown-eyed) people come to New York or leave New York to live in other places.

( ) Blue-eyed (or brown-eyed) persons acquire some advantage over the other type in health or length of life or fertility or in some other quality [illegible] which [illegible] the other [illegible]

[illegible]

New Genes by Mutation

We have now to ask a question important at the very root of the problem of evolution. What is the origin of the variety of genes which [illegible] in all populations? [illegible] why genes [illegible] It is not difficult to [illegible] why [illegible] blue eyes, both forms [illegible] brown eyes and [illegible] could persist in the population [illegible] either has [illegible] the other [illegible]

[illegible] (for amaurotic idiocy) is recessive to the [illegible] condition and that all the defectives die before they can have children The genes present in the defectives are always lost and their number in the population should decrease

Unfortunately there is no reason to believe that hereditary diseases are in process of disappearance In fact some figures make it look as though such diseases are becoming more frequent but this is probably a false [illegible] due to improved statistics and not to worse[illegible] During the few decades [illegible] century [illegible] for which anything like reliable statistics are available [illegible] hereditary diseases has probably re[illegible] table How can this happen if some defective genes are lost in every generation? The explanation is that some genes change from normal to defective by a process known as mutation

Mutation has been observed and studied chiefly in [illegible] So many millions of these have [illegible] under experimental control that [illegible] are rare thousands of them have [illegible] they are [illegible] easy [illegible] certain [illegible] to [illegible] very well the [illegible] children carry [illegible] amaurotic [illegible] C) [illegible] the [illegible] Mendel [illegible] of the [illegible] is born with some unexpected trait [illegible] then transmitted to the offspring of that [illegible]

Mutations to dominant traits are detected more easily than those to recessive ones this is because dominant [illegible] generally present in the [illegible] of the [illegible] but it [illegible] be manifest in their ex[illegible] recessive genes are [illegible] colored [illegible] born [illegible]

[illegible]ouisiana from normal colored parents proved to be piebald that is her skin was irregularly splotched with white She had fifteen children by a normal colored man eight of which were also piebalds At least five of these are known to have had in turn some piebald progeny while no piebalds were born to their non piebald brothers and sisters It is fairly sure that the [illegible] arose from a sex cell which con[illegible] This gene [illegible] of her off[illegible] [illegible]ant heredi[illegible] Several instances [illegible] tary defect not present in the pedigree appeared suddenly in a single child born of normal parents are recorded in the medical literature It is certain that at least some of these instances represent authentic mutations

Precisely why mutations occur in man or in other organisms we do not know as yet Mutations appear more frequently in the offspring of individuals treated with X rays high temperature and some chemicals But mutations also occur without any treatments For all we know they just happen It has for example been [illegible] every 100 000 human sex [illegible]

[illegible] ently arose from such [illegible] gene through her daugh[illegible] transmitted the haemophilia gene [illegible] and Spanish [illegible] and granddaughters to the [illegible] remarked that royalty An irreverent scientist [illegible] gene may having been a carrier of an [illegible] to fame eventually [illegible]

When all or a part of the victims of an hereditary disease regularly die without leaving progeny and nevertheless the disease does not become less frequent with [illegible] because the supply of diseased [illegible] of the [illegible] through death or [illegible] to the number of these genes arising by mutation [illegible] outgo and the income balance the disease becomes

neither more nor less frequent with time and what is known as the state of equilibrium is established

We can be absolutely sure that hereditary diseases and defects have not been brought about by the effects of civilized life It is absurd to say that these diseases and defects indicate degeneration of the species Natural populations of wild animals as well as domestic animals carry innumerable defective genes There is no doubt that such degeneration has accompanied all evolution including progressive evolution

The Grain and the Chaff

As stated above the occurrence of mutations is regarded in modern biology as the fountainhead of all evolution In every generation the process of mutation adds a variety of genes to the gene pool Next sexual reproduction and Mendelian recombination bring these genes into new combinations And finally natural selection is the great thresher which separates the grain from the ch[illegible]
the process [illegible]
materials [illegible]
could [illegible] and natural selection accomplish the man[illegible]
[illegible] itself

A seemingly very grave objection to the theory of [illegible] have occurred to the reader We have [illegible] mutations [illegible] produce such serious hered[illegible] as hemophilia [illegible] such traits as piebald [illegible] If we were to describe more examples of mutations in various organisms it would plainly appear that most of them are harmful or at least useless to their carriers But harmful mutations can only lead to degeneration of the species so how can such mutations improve the fitness of their possessors?

The answer [illegible] the puzzle is simple enough In the [illegible] have forgotten an important [illegible] —the environment The fitness [illegible] carriers of a pa[illegible] [illegible] environments but

high in others In man light-skinned and especially albinotic individuals often suffer painful sunburn while persons with pigmented skin are relatively protected from this danger On the other hand there is some evidence that light skins permit their possessors to secure a supply of vitamin D (the sunlight vitamin) more easily than do dark skins Are then the genes which make the skin white useful or harmful? The question is evidently meaningless if the environment is not specified Light pigmentation may be useful in countries with scarce sunshine and dark pigmentation in climes with strong sunshine The ability to withstand intense heat is very useful in the jungles of Africa or of Brazil but it is resistance to cold which counts most with the inhabitants of Greenland or Tierra del Fuego

A group of botanists transplanted certain plants native on the seacoast of California to high mountain meadows the transplanted individuals died because of their inability to stand the long mountain winters On the other hand when races of the same plant species which grow naturally on mountain meadows were transplanted to the coast they proved very susceptible to attacks by a disease-producing fungus (mildew)

Some people like to believe that all men are born not only equal in rights but also biologically alike But facts show clearly that people are not alike In man as in other biological species which reproduce sexually actually no two individuals have the same hereditary endowment (identical twins excepted) Biological differences are not incompatible with equality equality is not a biological but an ethical principle And in the light of the evolution theory we can understand why men are not all alike It is because the world in which we live is tremendously diversified It has plains and mountains woods prairies and deserts rich and poor soils tropical isles and arctic tundras places where food [illegible] plentiful and others where it is difficult to come by

When a species is confronted with a variety of opportunities for life it usually evolves a variety of types that

are able to exploit these opportunities most efficiently. This diversification is made possible by the mutation process which furnishes the genetic raw materials from which diversity can be built.

A mutation may be harmful in one environment [illegible] useful in some [illegible] For example [illegible] useful in others. This does not mean that every mutation must necessarily be useful in some environment. Most mutations, such as the human hereditary diseases discussed above, are injurious in [illegible] even [illegible] known environment [illegible] It may then be asked [illegible] Why should harmful mutations occur [illegible] at all times? Would it not be vastly more [illegible] for its evolution [illegible] useful [illegible] were to take place only when and where they are needed? That would certainly spare mankind no end of the suffering caused by defective heredity.

The answers to these questions are not difficult. This is not a perfect world. Mutations are changes [illegible] in nature which alter the structure of the genes and the [illegible] To provide [illegible] environment [illegible] not only [illegible] expected [illegible] mortal creatures with [illegible] All kinds of [illegible] the genes [illegible] stretch of [illegible] hereditary [illegible] A few of these changes will be useful to the organism in some environments. A majority of changes will be harmful just because tinkering with the complex mechanism is more likely to spoil it than to improve it. A more biological reason is that the mutations which are useful [illegible]

is made up of mutations which occurred in our remote ancestors and which did prove more or less useful. For it is just this accumulation and combining of useful mutations which transformed our prehuman forebears into the human species.

Harmful mutations such as hereditary diseases are thus the price which the species pays for the plasticity which makes continued evolution possible. A harsh and cruel price it is. It is for the human mind to seek to minimize this price, if it is not possible to do away with it altogether.

5 Controlling Man's Heredity

MAN is a relatively newcomer on the earth. The most [illegible] pretty much like the [illegible] now living, [illegible] ly between 70 and 80 thousand years ago. And the first light of recorded history dawned in the valley of the Nile only some six thousand years ago. On the time scale of biological [illegible] to the [illegible] recent [illegible] millions of years. And yet the [illegible] development of [illegible] election has enabled him to evolve his culture and to work tremendous changes on the face of the earth. He has modified [illegible] many species of animals and plants which he has domesticated, has exterminated many wild species, and has altered the [illegible] of a large portion of the [illegible] He [illegible] powerful [illegible] ly [illegible]

One [illegible] ted [illegible] entirely. This [illegible] ny—[illegible] hereditary endowment [illegible] ly surpris [illegible] very recently he knew very little [illegible] heredity [illegible] such [illegible] knowledge [illegible] well [illegible] more [illegible] than good [illegible] Although the knowledge [illegible] ly unst [illegible] story [illegible] century [illegible]

It [illegible]

No matter how [illegible] people [illegible] agree with each other [illegible] in their cogni [illegible] any things they [illegible] the world in which we live is far from perfection, that the world [illegible] which we live is far from perfect [illegible] and needs improvement. There [illegible] distressing amount of disease [illegible] deficiency [illegible] individual human [illegible] human societies do not always act [illegible] as they should. The [illegible] function [illegible] ly [illegible] they [illegible] and the ability to [illegible] fection with [illegible] they [illegible] the prime movers of all things, as they ought to be [illegible] progress. Now there are two possible ways to [illegible] progress. Now there are two possible ways [illegible] one can change the people (or other organisms) [illegible] environment in which people grow up—the nutrition [illegible] education, political systems, etc. [illegible] so that [illegible] people will be healthier, happier, more intelligent and morally upright. This is euthenics. Secondly, one [illegible] born with hered [illegible] tary defect [illegible] of superior [illegible] the genes [illegible] ities [illegible]

Eugenics and [illegible] both [illegible] to improve people [illegible] existing [illegible] But [illegible] equipment will be brought [illegible] potentialities [illegible] the genetic [illegible] realization [illegible] ly [illegible] mankind [illegible] You [illegible] cally [illegible] of their lot will [illegible] ocial [illegible] So let [illegible] Of [illegible] carry [illegible] of [illegible]

frequently [illegible] well if [illegible] In [illegible] complete [illegible] physical [illegible] mental [illegible] effectively.

Here it must be [illegible] heredity is not [illegible] to [illegible] defec[illegible] More [illegible] people [illegible] Here [illegible] of science [illegible] to [illegible] from other [illegible] hered[illegible] Similarly [illegible] comment [illegible] the [illegible] heredity [illegible] nevertheless [illegible] the [illegible]

[illegible]

It [illegible] time [illegible] positive [illegible] reac[illegible] opinion [illegible] of [illegible]

More [illegible] has been shown in many place[illegible] negative eugenics which urges elimination of un[illegible] genes by discouraging or making it impossibl[illegible] persons who show the effects of such genes to have c[illegible] dren. Such voluntary abstention from parenthood [illegible] difficult [illegible] sterilization for individuals who are lik[illegible] *to have severe hereditary defects is recommended.* St[illegible] accomplished through a surgical operat[illegible] [illegible] and which is [illegible] by no means unsex[illegible] show no outward signs of having undergone the t[illegible] ment but are unable to beget children. Sterilization laws are now on the statute books in many states [illegible] countries. Some of these provide for [illegible] only with the consent of the person [illegible] or [illegible] guardian; others make it compulsory [illegible] by the court.

Many [illegible] believe that putting their pro[illegible] into practice would improve the physical and me[illegible] *[illegible] within a few generations.* Some of the more enthusiastic ones have put for[illegible] predictions. For example, one of the [illegible] International Congress of Eugenics held [illegible] New York [illegible] stated that [illegible] enforced throughout the *U*[illegible] States [illegible] less than one hundred ye[illegible] percent of [illegible] and [illegible] many other forms of defectiveness and [illegible] within a century our asylums, prisons [illegible] would be largely emptied of their pr[illegible] However [illegible] be [illegible] examination of the possibilities of [illegible]

Controlling Harmful Dominant Genes

The purpose of negative eugenics is to [illegible] hereditary [illegible] and other traits which are con[illegible] Here is no practical [illegible] the carriers of un[illegible]bl

[illegible] would not desire to [illegible] them [illegible]. The [illegible] must then prevent or [illegible] by the [illegible]

Natural [illegible] applied [illegible] method [illegible] [illegible]

[illegible] When [illegible] [illegible]

relatively late in life after the gene has already been passed on to the next generation. Nevertheless there [illegible] prevention of reproduction on the part of possessors of bad dominant genes would quickly reduce the number of such genes.

But not all of bad heredity is due to simple dominant [illegible] hereditary [illegible] than one gene [illegible]. Take for example Mongolism [illegible] Many children with the mark [illegible] skull [illegible]

Mongoloid [illegible] each year. There are a number of cases in which both members of a pair of identical twins [illegible] Mongoloid [illegible] among fraternal twins [illegible] Mongolism is hereditary. [illegible] child in a family [illegible] possible that more than one gene [illegible] different genes together determine the abnormality. But [illegible] the result [illegible] thing about Mongolism [illegible] that in a family with the hereditary tendency to produce [illegible] children it is much more frequent after the mother has passed the age of [illegible]. Th[illegible] Children of young [illegible] of Mongol[illegible]

Controlling Harmful Recessive Genes

The problem of getting rid of bad heredity [illegible] are [illegible] for control [illegible] unless [illegible] genes.

Here [illegible] recall that every human being [illegible] *Aa* and *aa* [illegible] certain [illegible] *Aa* people [illegible]

[illegible] the [illegible] recessive [illegible] dioecy [illegible] only in the *aa* class while [illegible] will be [illegible] in the *Aa* class. Now it happens that children afflicted with recessive diseases and abnormalities are born mostly to parents who are only heterozygous for the defective gene and are themselves [illegible] normal. [illegible] only [illegible] *Aa* [illegible] to say [illegible] of [illegible] partly be prevented.

What proportion [illegible] equally frequent [illegible] per cent of an [illegible] *a*. But [illegible] there are nine times [illegible] gene *a* [illegible] then [illegible] 81 per cent [illegible] 18 per cent [illegible] per cent [illegible]. Here the [illegible] more frequent than the [illegible] the less frequent [illegible] the [illegible] of the [illegible]

[illegible]

This shows clearly that if a gene for a recessive disease or abnormality is rare, nearly all of the genes will be found in *Aa* people who are themselves perfectly normal, although of course they transmit the disease to their offspring. In England, for example, about one in every [illegible] people is an albino. This means that in the gene pool a little more than ninety nine per cent of the genes are *A* (the gene for normal pigmentation) [illegible] one per cent are *a* (the gene for albinism) [illegible] per cent of people will be *Aa* (normally pigmented carriers of albinism). [illegible] times as [illegible]

Now suppose that we [illegible] to have a race of people who can all taste PTC. Taste-blindness for PTC is to be regarded as harmful [illegible] to be purged from the race for good. (Actually those who can taste PTC are of course neither superior or inferior to those who cannot.) To [illegible] we should [illegible] others [illegible] prevent the taste-blind people from having children. Since taste-blindness behaves in heredity as a recessive trait, all the taste-blind persons are in the *aa* category. Thus we can stop all of the [illegible] genes in the *aa* people from going on to the next generation. But the gene for taste-blindness is found in *Aa* people as well, and *Aa* persons happen to be about twice as numerous as are *aa* people. Thus even if all the taste-blind people are [illegible] the gene for taste-blindness will be [illegible] Some taste-blind [illegible] will [illegible] the next generation.

[illegible] slightly below [illegible] the frequency of taste-blindness in the United States [illegible] gene [illegible] per cent [illegible] in the population will decline [illegible]

[illegible]	[illegible]
Initial	
1	11
	6
	1
1	
1	8
[illegible]	11
	01
1	01

One [illegible] first [illegible] of the [illegible] is [illegible] to [illegible] So [illegible] B[illegible] that [illegible] the frequency of [illegible] from 6 to [illegible] per [illegible] generations [illegible] about [illegible] per cent [illegible] generations [illegible] sterilization [illegible] would carry the [illegible] down to [illegible] per [illegible] ten more generations [illegible] population [illegible] society [illegible] The [illegible] fed for the [illegible]

[illegible] might [illegible] than [illegible] As [illegible] above [illegible] been [illegible] more [illegible] population [illegible] There [illegible] per [illegible] the [illegible] of [illegible] would [illegible]

years?) to reduce the proportion of albinos in the population to half the present frequency.

Now the [illegible] of the above table become [illegible] Where a recessive gene is [illegible] in the *aa* form that [illegible] how it affects its frequency [illegible] quickly reduced by preventing the reproduction [illegible] the recessive gene [illegible] sterilization program become less and less effective.

Now we [illegible] that the sterilization [illegible] that not a single [illegible] sterilization. It is of course doubtful [illegible] could [illegible] in practice. But [illegible] complete compliance [illegible] the dependence of the [illegible] would be mostly [illegible] of [illegible] already discussed this matter [illegible] carriers of un[illegible] (p. 80). The progress is much [illegible] slowed down [illegible] defects in heredity [illegible] and therefore escape steri[illegible]

[illegible] a certain population [illegible] a recessive [illegible] the next [illegible] of the [illegible] 6 per 10,000. But [illegible] defect will appear [illegible] sterilized the defect will [illegible] out of each [illegible]

[illegible] of neg[illegible] for the very [illegible] may [illegible] so [illegible] not mean that [illegible] defect [illegible] world [illegible] due to defects [illegible] so many different [illegible]

[illegible] extremely [illegible] We have [illegible] that at least [illegible] per cent of the more than [illegible] blind persons in the United States suffer from [illegible] eye diseases. This [illegible] deal of human misery. But the frequency of [illegible] blindness [illegible] per 10 000 individuals [illegible] low frequency [illegible] different hereditary [illegible] known [illegible] that the incidence [illegible] taken separately [illegible]

[illegible] present [illegible] more [illegible] blindness [illegible] certain [illegible] have little or nothing to do with heredity. [illegible] attributable to defective heredity are of many kinds which can be more or less easily distinguished [illegible] specialist [illegible] due to [illegible] frequency [illegible] for the total population of the [illegible] which [illegible] account [illegible]

[illegible]

We have seen that the effects [illegible] their [illegible] Only [illegible] presence of the [illegible] new mutations [illegible] could [illegible] thorough [illegible]

of the emergence [illegible] lessened still further. Nevertheless where [illegible] defective genes are involved elimination of their carriers from parenthood would unquestionably benefit the coming generations.

Where defects due to recessive genes are concerned the efficiency of sterilization is in general low. Only if a recessive defect [illegible] very common in the population can [illegible] persons produce a [illegible] of their numbers in the next generation. For defects which are [illegible] or caused by recessive genes which [illegible] only [illegible] certain environments or [illegible] recessive genes present in the same individual very little is accomplished by sterilizing even all the defectives in a single generation. To be sure if [illegible] program is continued for many generations the defects will become eventually less common [illegible] The process may however [illegible] dilemma.

On [illegible] to [illegible] worthwhileness of such [illegible] clear to us is the [illegible] to the [illegible] too well [illegible] to tackle [illegible] problem [illegible] better [illegible] discovery of such [illegible] with recessive [illegible] (heterozygotes). [illegible] of a gene which [illegible] case (Cooley [illegible]). Extension of this ability [illegible] only on the progress of research will [illegible] of the same recessive [illegible] if they have children [illegible] of carriers of [illegible] progress [illegible] let us not forget that [illegible] which will achieve [illegible]

[illegible] other [illegible] hereditary defects [illegible] [illegible] diabetes.

On the other hand, it may still be argued that even [illegible] of little effectiveness [illegible] [illegible] over [illegible] [illegible] [illegible] teaching [illegible] [illegible] likely [illegible] [illegible] With [illegible] [illegible] promise [illegible] [illegible] [illegible] more the r[illegible]re of happ[illegible] life [illegible] the field of social reform.

[illegible] H[illegible]ds

N[illegible] [illegible] [illegible] hereditary [illegible] [illegible] mutation by mutation [illegible] Mutation of our genetic good genes also [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] the ex[illegible] [illegible] harmful mutations is likely to become [illegible] increased.

The use of X-rays [illegible] [illegible] [illegible]

powerful known means *for increasing the frequency of mutations*. If then no sufficient care is exercised so that the sex glands (ovaries or testes) of the patient are irradiated when the patient is treated with X-rays, mutations will be [illegible] in one of his sex cells. The *mutations [illegible] that it is completely* [illegible] either to the patient or to the physician. But [illegible] the patient [illegible] he is likely to transmit a mutant gene to his offspring. If this gene is dominant the child born with some defect which will in all likelihood not be ascribed to the treatment at all. But if the mutation is recessive then several or even many generations may elapse before the harm becomes apparent.

The release of atomic energy, whether for constructive or for destructive ends, will expose to mutation-inducing radiations even greater numbers of people. Of course if the sex glands are shielded from the radiations used for medical purposes or produced in atomic energy plants the number of harmful mutations in the [illegible] will [illegible] be [illegible]. One must only remember that there is no such thing as a *safe dose of radiation*; the *number of mutations induced* is simply proportional to the amount of radiation reaching the sex cells, and [illegible] exposure [illegible] to small amounts of the radiation [illegible] will [illegible] up to very high [illegible].

M[illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] undoubtedly be exposed to mutation [illegible] killed or maimed will be the obvious [illegible] but those who survive will transmit to their immediate and remote progeny some defective heredity which will add to human misery during centuries [illegible] millennia. The defective [illegible] gene pool will be slowly [illegible] but remorselessly [illegible] to plunge mankind into

[illegible] calamity or to save it from [illegible] should [illegible] because [illegible] of them [illegible] the reproductivity [illegible] how the con[illegible] now

D r n I I lity

[illegible] States [illegible] in the United [illegible] between [illegible] countries [illegible] in the [illegible] differential [illegible] birth rates [illegible] in the [illegible] country [illegible] except [illegible] country [illegible]

[illegible] A [illegible] Lydia [illegible] Careful [illegible] the slack [illegible] which [illegible] to [illegible] the following [illegible] of child

M n s l	
None	Children
[illegible] year [illegible]	3 [illegible]
7 8 years of [illegible]	1 33
[illegible] years of [illegible]	3 [illegible]
1 year of [illegible]	[illegible]6
[illegible] years of [illegible]	37
[illegible] years of college	[illegible]
	[illegible]
	[illegible]

[illegible] incomes below $1 [illegible] many children [illegible] between $[illegible] and $5,000 and [illegible] families [illegible] fifty per cent more children [illegible] annual income of $5000 and over [illegible] farm laborer [illegible] more children than farm owners [illegible] skilled [illegible] unskilled ones and [illegible] fewest children [illegible] groups which have [illegible] how [illegible] IQ [illegible] To example the [illegible] groups

[illegible]	[illegible]
Business Clerical	[illegible]
Skilled Workers	1 0
Unskilled Workers	1 3
	[illegible]

The [illegible] fertility [illegible] careful [illegible] The [illegible] United States [illegible] there [illegible] countries [illegible] of which [illegible] It stands [illegible] quality [illegible] and [illegible]

tl t a family f t t em pr s f npl r ne g ts I Hers per r t tl t fa f ls f p s But se cet ct t l ne co pt ident ft cse f t n po apt y v s h I f t yere t oull t ke the ftn o pect f m nk nd l e k d e I

The c y a me t rs l t s follot The lifferent f fertility f the soc l l e means th t the future generation will be de ended to a greater extent f t tl o e fertile th t f tl ls fertl l es. I e t re fertil cl s are have er lower a verage nt l tl the les f rtl g p He t l e t p l l ve efect p t ster l e l tl t lves by le v g the bu ness of childbearing chiefly to the l s well endowed group Now human telli gence t p t l er dit y (see Ch t) The av ge t l ge t of g ne t ll ate lc l tl t f ile p t re S t l p t thr t l e l t e l l e tl e g e IQ of the A e p l pl l k l y l t l t pe g t Otl r t t xpe t e t e p l l l t p l t p r g e t Ill t l t wll f t o tr n f r n to t n of o e c t t Wh t s the t t tl e t of t l g l ott p n e s t t no e y!

I tl d t r lly e v t l Se l e o ts t l v t l e t h n the existence f g etic c ponent t tle l p n e e t l t n t l e Bet t t p t t l se p l tt f n the ts n st be to e n l t le t t th l ll e r e t IQ vere c ol erved l et e y vorker s l l r nes n t have the same get t e o ponent l l l v l l v tl t o l l s y l e genetically differ t f ex nple n eye e l t o t ntell ce e b t t l t not follow that the l ller

f n t ly l ll t l l s l l v t t y l ts o ll t g l o p o e th t tl IQ l ll t l t l te g t o l l l ne t l e t p l l t t t t vto ll tly l p of l t t

v k n f l ssi t t an l to ol erve the re lt S l t st t ne l t t t l e t made

A p nt l l v l e t lone f me t t ale IQ f l ry ll hillren n Scotl l t t 193 tl t 193 It h s been known th t t Scotland t cl e t l e t t l e ge the more intelligent classes produce fewer chillren per family than tl l s ntell ge it nes The biol t l select on against in telligence was therefore expected to produce a per ceptible drop in the e e n ntelligence within the t te f t v r — n re th n l ll of n average h man generation te et t ntell l e oun l y e r Mor tl n 8 thou t l children were tested in 193 nd nore than thousand children in 1947 The number of eleven year ll el ll e n Scotland that were n t teste l re t t l t l e less th th l th t th t t p st n al t t l result obt t l g e rate le f tl s IQ f tle l s y ll S tt l el ll s N tl ver e re f r ny p v l ts t p t t l r tl t ngl l tl h tl t s lt rt t l e t p t l t ve t tl t the S t h l l l f t g l l y tlly telligence t e lly gives support to the

e y f l t t t f t ll g t

It t n e p over th t l l ter e h eate l mother t l f th t l e l e h ll t tly l they re better e l u t l l t nl o p o ll th t one parent a e l ette t h e t l l t the y h e f ver chillren Early t t ge of mot h f vors greater fecundity n l e rly m t r ge may interfere with the completion of a course o e l e tion An l vice versa a willingness to postpone tle t f t s l rmi g l l t ly l tt t t t k t e t e to p r e n e l cation Ag n the resp l lities of f mily life y re tr t the freedom of e t f tl p t r l tl s t fore tl tl t p t l p tl l l d l r an l s th the growth f tl t t l t y Smt n s lo tl t l l t l ve l r n ll e l veo the a er ge m f ll t l f l l kee ps bene h re Bt

not necessarily [illegible] poor housing [illegible] children, because families with many children may sometimes be forced to occupy more modest dwellings. Some people have been notoriously rash in giving biological interpretations to social and economic facts.

[illegible]ed Characters

The sound core of eugenics is that it draws attention to the need of scientific study of the human gene pool [illegible] of practical measures to control the contents of the pool in the best interests of mankind. Unfortunately eugenics has often been perverted to a pseudoscientific justification of social inequity and oppression. It [illegible] common knowledge that complete equality of opportunity [illegible] not exist in the United States or in other western [illegible] countries [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]. And [illegible] [illegible] [illegible] [illegible] conditions [illegible]. Let us not forget the [illegible] poverty of the teeming masses contrasted with the extravagant luxury of a small minority. The notion that the underprivileged classes are biologically inferior to the favored ones is merely a convenient [illegible] specious vindication of the injustice which in any case is not biologically inevitable.

Nor [illegible] those who have urged [illegible] for the relief of human misery [illegible]

individual [illegible] environment. When a parent [illegible] [illegible] environment the responsibility [illegible] children are [illegible] [illegible]. Educational achievements of the parents are not inherited by the children; children have to be educated for themselves. Neither [illegible] [illegible] acquired vices of our parents nor the characters [illegible] bad [illegible] brought about by accidents, malnutrition, sorrow, and the like.

The notion that acquired characters are inherited is very old. In fact, it started not as a scientific theory [illegible] [illegible] popular belief. It [illegible]

[illegible] characters [illegible] [illegible]. Later this idea became [illegible] [illegible] Lamarck, the pioneer of evolution [illegible]. Lamarck believed that bodily parts and [illegible] strengthened by exercise and [illegible] weakened by prolonged disuse. He supposed that [illegible] occurs because animals make efforts to get food, to escape from enemies, and the like, and in so doing exercise and develop special parts of their bodies. For example, Lamarck supposed that the giraffe got its long neck because the remote ancestors of the giraffes stretched their necks in their efforts to get at the foliage [illegible] the normal food. The [illegible] [illegible] whether the offspring of those giraffes which stretched their necks are born with longer necks than they would otherwise have had. Strange as it [illegible] Lamarck [illegible] this question at all—[illegible] [illegible] would be [illegible]. Darwin [illegible] evolution occurs by [illegible] (see Chapter 9) [illegible] [illegible] giraffe [illegible] [illegible] [illegible] secured a real advantage [illegible] [illegible] progeny [illegible] [illegible]. Nevertheless Darwin shared the belief which was universal [illegible]

course, transmitted and become inherited. He even invented what he himself called a provisional hypothesis of pangenesis to visualize how such inheritance might take place. According to this hypothesis every part of the body produces a kind of diminutive copy of itself, which he called a [illegible]ne. These particles are transported by blood to the sex glands, where they unite to form the sex cells. A body part which has acquired a new character [illegible] the muscle[s] of which have been [illegible] the [illegible] altered [illegible]gene, and this [illegible]gene will produce a similar effect on [illegible] the progeny.

Darwin knew that his *hypothesis of pangenesis* was just a guess; this is why he stressed its provisional character. But it fulfilled the most important function of any scientific hypothesis: it stimulated a great amount *of research and experimentation. For at least thirty years* many biologists, among whom the names of Weismann and Galton should be mentioned most prominently, made studies on plants and animals to see *whether acquired characters are ever inherited.* The number of believers in this contingency dwindled steadily because the outcome of the experiments on inheritance of acquired characters was so uniformly negative.

The rediscovery of Mendel's laws and the development of genetics in the current century have produced a *much better understanding of the* mechanism of heredity than was available in Darwin's and Weismann's day. In the light of this understanding we can clearly see why acquired characters are not inherited. This is because heredity is transmitted through genes and not through blood mixtures (see Chapter 9). Genes [illegible] *from each other* by division [illegible] they [illegible] [illegible] organs of the body [illegible] and not tran[illegible] the reproductive [illegible] sex cells [illegible] [illegible] on food. The [illegible] a by-product of gene reproduction and not vice versa.

Lysenko's Michurinism

An agronomist named Lysenko has recently secured for himself a high prestige and power in the Soviet *Union and much notoriety elsewhere* by his attacks on modern genetics and by his advocacy of the so-called "Michurinian" theory of heredity. Lysenko's views have in recent years figured so much in the popular press and have aroused so much passion that we are forced to give them a brief consideration, despite the fact that they simply cannot be taken seriously by anyone familiar *with the fundamentals of modern biology. For the* queerest thing about Lysenko is that he has produced no new theories, either right or wrong ones. His assertions that acquired characters must be inherited differ only in greater vehemence from those made by the immediate followers of Lamarck and Darwin in the last *century. Lysenko has revived Darwin's hypothesis of* pangenesis, although he does not call it by that name and does not acknowledge Darwin's authorship. Fur*thermore he denies without cogent reason* the validity of Mendel's discoveries and of the theory of the gene built on them. Lysenko also denies the chromosomal *theory of heredity, with which he does not seem to be* very familiar. If the word "reaction" means retreat to an outworn stage of the development of a society or a *science,* Lysenko's *"progressive dialectical" theories* are certainly reactionary, since they simply do away with at least half a century of biological thought.

Lysenko *claims that his negation of modern biology* is supported by the work of Michurin (18[illegible] 193[illegible]), a successful fruit tree breeder whom a propaganda campaign in the Soviet Union has now raised to the status of [illegible] to Michurin unquestionably had [illegible] use a number of very [illegible] Michurin was an amateur in biological science. Although in his work he followed the classical methods used by al[illegible]

an[illegible] b[illegible] c[illegible] rs h[illegible] achieved [illegible] success to some fanciful the[illegible] [illegible] n[illegible] mention. To be fair to Michurin, this [illegible] y[illegible] t[illegible] th[illegible] fancies were not so much out of time [illegible] th[illegible] [illegible] ties of [illegible] [illegible] younger days. Th[illegible] [illegible] [illegible] to a belief [illegible] [illegible] [illegible] e [illegible] acq[illegible] r[illegible] *characters* [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] *eget*[illegible] hybridization. In many plants it is possible to graft buds or twigs of one variety of tree onto another variety. Not infrequently the leaves and fruit developing from these scions show an influence of the foreign stock or vice versa. Michurin believed that this influence persists also in the offspring obtained from the grafted tree. He also believed that the heredity of a young or a recently transplanted tree is somehow unstable, but that it solidifies afterwards. Lysenko's followers claim many *wonderful transformations of heredity. The most* extravagant of these claims is that by planting common wheat under unfavorable conditions one can transform it not only into a wheat of a different species but even into rye. This is like obtaining from your pussycat a fox cub or even a bear cub.

All that one can say about these claims is that every type of experiment in Lysenko's arsenal was performed by biologists *before him with results that fail to support* him. And wherever his work is repeated by biologists and plant breeders outside the Soviet Union the results contradict Lysenko's assertions. The sad part of the Lysenko story is, however, that his theories have been *endorsed by the rulers of the Soviet Union* and that opposition to them is no longer tolerated in that country. Dissent[illegible] [illegible] unorthodox views are often useful in science even when they are wrong, because they may stimulate more careful thinking and research. But there can *be no justification* whatever for the use of intimidation, imprisonment and exile to establish the [illegible] end of [illegible] doctrine [illegible] r[illegible] [illegible] to [illegible] n[illegible] The [illegible] [illegible] of genetics [illegible] has [illegible] yet [illegible] destroyed in the Soviet Union [illegible]

Can Genes Be Changed by the Environment?

Bodily or mental traits acquired during an individual's life are not transmitted to his offspring. The refutation of the view that acquired characters are inherited has, however, been widely misunderstood as meaning *that the heredity, the genes, are unchangeable or some*[illegible] [illegible] from the environment. It must be ad[illegible] [illegible]

to Lysenko the pretext to declare [illegible] mystical and even pseudo-scientific

That genes can be changed by the environment is indeed self-evident. Although the exact chemical make-up of the genes is not known, they consist of a kind of *chemical substance (nucleo-protein) which is extremely* complex and can undergo changes in many ways. To give a crude example, when you boil eggs for your breakfast *you surely change the genes contained in these* eggs by heat. Or, you can kill the sex cells of any organism by any one of a great variety of poisons and this will also change the genes carried in the sex cell. The *important problem is evidently not whether genes can* be changed, for they clearly can be, but what are the consequences of the change. And here it appears that the mo[illegible] [illegible] k[illegible] Th[illegible] [illegible] er that the [illegible] [illegible] *which it is not likely to be spoiled by any* [illegible] ody expects to improve his [illegible] by poking a stick into its mechanism. The changes in the gene which are interesting *to us are of a very special kind.* They must be retained when the gene reproduces itself by making its copy from outside materials from food. Such changes are *called mutation (see Chapter 4) and they occur* relatively rarely. The statement that the heredity of an *organism can not be* changed merely means that we do not yet know how to make the genes of a certain kind [illegible] te to a [illegible] re[illegible] [illegible] state.

But [illegible] [illegible] kind of control over the mutation process

not mean that the heredity can not be changed by environment or by human effort. The hereditary [illegible] is an out[illegible] trolled by [illegible] ural selection [illegible] of the environment which changes [illegible] subtle but [illegible] very effective [illegible] by letting the well adapted organisms survive [illegible] reproduce and by failing to perpetuate the genetic [illegible] which are out of tune with their environment. [illegible] has followed the example of nature when he [illegible] by artificial selection the heredity of his domesticated animals and plants to serve his needs [illegible]. And the obstacles in the way of the application [illegible] methods to the control of human heredity are chiefly social [illegible] origin.

6 Race

IT IS AN old human habit to believe that one's own family or race [illegible] better than the neighbors, but it is a relatively new idea to ascribe this superiority to inherited biological qualities. The Greeks of more than [illegible] years ago felt quite sure that they were better than barbarians [illegible] generously defined as all non-Greeks, but they regarded the barbarian as inferior not because there was anything wrong with his body, *but because his [illegible] manners, so to speak, were so bad. The Greeks could also detect the same superior attitude in* other peoples of antiquity. As far back as the fifth century B.C. Herodotus, the great historian, wrote with subtle irony that Persians look upon themselves as very greatly superior in all respects to the rest of mankind, regarding others as approaching to excellence in proportion as they dwell nearer to them; whence it comes to [illegible] be the most [illegible] led so much [illegible]

Mohammedans [illegible] often [illegible] *particular* [illegible] *yet they always accepted without* [illegible] anyone [illegible] embraced their religion. The early Christians in general adopted the same attitude, paying little attention to biological or racial differences, since they regarded as fundamental those differ

pears in th

ors And so anxious have some w
burden upon themselves that they used their

other

opa
com

cation

to assign all men to the species *Homo sapiens*
for *man* sapiens for *wise* an opinion which we should
ly only dare express in Latin!) Linnaeus placed
cies at the pinnacle of the animal kingdom
aeus knew of course that the men who inhabit
of the world are not all alike and so
species into four varieties as

ican Indian)—Tenacious con
tented d by custom
europaeus—Light lively inventive ruled by rites
asiaticus—Stern haughty stingy ruled by opinion
afer (African)—Cunning slow negligent ruled by
caprice

The first classification was as we see based on char
acters of the mind and not of the body The fault of
was that it didn t classify contented
ent people can be found everywhere
(1775) the German scholar Blumen
f anthropology the scientific study of
o divide men according to skin color
es and to each of these varieties was
race a term which had been em
ployed earlier by the French scientist Buffon The five
races of Blumenbach were

Caucasian or white
Mongolian or yellow
Ethiopian or black
American or red
Malayan or brown

This [illegible] a biological classification which obviously [illegible] between [illegible] people [illegible] in [illegible] all [illegible]

Other [illegible] anthropologists thought that skin color [illegible] [illegible] as a trait and they resorted to measurements [illegible] and proportions of the body particularly of the [illegible] Races were recognized by head shape in conjunc[illegible] hair [illegible] combinations of other traits nearly [illegible] are present to some degree in all races [illegible] were not constant within any race [illegible] [illegible] sharply [illegible] than the same [illegible] characters [illegible] of [illegible] multiplied to a great multiplica[illegible] of race Deniker in 1889 recognized 29 of the [illegible] [illegible] hair form with skin color and nose [illegible] traits In 19[illegible] von Eickstedt set [illegible] races Europid Negrid and Mongolid [illegible] 18 subraces [illegible] collateral races [illegible] collateral [illegible] intermediate forms In 19[illegible] the [illegible] anthropologists Coon Garn and Birdsell [illegible] stocks—Negroid Mongoloid [illegible] loid American Indian and Polynesian— [illegible] different races

[illegible] it has emerged from such efforts [illegible] [illegible] The confu[illegible] [illegible] to distinguish groups resembling [illegible] other biologically from those united in a nation [illegible] or [illegible] large community American as applied to citizens [illegible] States can certainly denote no biol[illegible] [illegible] no American race [illegible] it be the [illegible] [illegible] [illegible] Co[illegible] be biologically [illegible] ants of northern [illegible]

physically the inhabitants of Denmark and Sweden more than they do the South Germans who in turn are physically similar to some Frenchmen Czechs and Yugo[illegible]slavs You will not be able to dist[illegible] by sight some Swedes Finns and Russians yet they speak very differ[illegible]ent languages

It is very [illegible] to [illegible] differences amongst peoples [illegible] [illegible] required that [illegible] Dress and decoration [illegible] or religion [illegible] even hair do may make some people seem dissimilar as [illegible] group from the very population from which they are descended If one were to arrange a guessing contest as to what race certain particular Europeans belong it would have to be conducted either without any cloth[illegible]ing or decoration at all or with the neutral uniform of dress [illegible] soldiers [illegible] [illegible] of the city [illegible] spreading throughout all [illegible] [illegible] often been inferred [illegible]lations R[illegible] from characters [illegible] [illegible] tory as these

The misuse of [illegible] for political and military pur[illegible]poses has [illegible] the term race into such disrepute that [illegible] scientists propose to abandon the [illegible] applied to human groups [illegible] By the human race we certainly do not mean the same thing as the races of man nor does the latter convey the same meaning of race as intended in [illegible] discussion of the races of Europe and yet there are human entities for which the term race if properly used could stand [illegible] of the ill which [illegible] uses of that notion the race notion [illegible] have brought about then it might be better to convey the idea of race in other words Some have used ethnic [illegible] race [illegible] fortunately ethnic [illegible] race [illegible] [illegible] [illegible] [illegible] as [illegible]

Any one [illegible] that the [illegible] of Clut[illegible] [illegible] differ in app[illegible] from those [illegible] and the [illegible] porter [illegible] [illegible] differ from trait

individuals in a group. These are facts which require [illegible] understanding [illegible] will not [illegible] no doubt that [illegible] idea of race [illegible] held by the older anthropology [illegible] both invalid, but it takes some effort to see where the fallacy lies.

How Races Are Distinguished

How does a layman, and how does a scientist arrive at the idea of race? Suppose that we consider the inhabitants of an American city such as New York. We [illegible] kinds of people who live in different [illegible] Harlem, in Little Italy, in the [illegible] Brooklyn, and [illegible]. As laymen we [illegible] the facial and bodily traits which are [illegible] the different groups. In Harlem the majority of people have dark skins, tightly curled hair, broad [illegible] and we know that these have come [illegible] African ancestors. In the Norwegian colony we [illegible] many tall people, many blonds, and many with [illegible] eyes. Persons of Italian descent tend to be [illegible]. Among [illegible] South [illegible] descent [illegible] are not *likely to* [illegible] stature, brown hair, fair skin and round heads. We might continue [illegible] among the [illegible] neighborhoods of the city [illegible] four groups or races. [illegible] Europe [illegible] central Europe [illegible] south Europe [illegible]. Some anthropologists [illegible] Negroes, Nordics, Alpines and Mediterraneans. Having [illegible] described the Negroes or Nordics we [illegible] a sort of composite picture of all the Negroes or all the Nordics [illegible] we may [illegible] as typical, and [illegible] the Negroes and Nordics in general.

[illegible]

certain group, he has calculated the *average* stature, average head shape, and the averages of other bodily characters. He [illegible] this set of averages as the characteristic of the group.

At this point, whether we have reached it by scientific or by laymen's methods, the trouble begins. In the first place we may make the mistake which has been so common in the past of assuming some necessary connection between the physical characters which we have observed or measured and the mental and cultural characters of the group. [illegible] color, hair shape and lip thickness of Negroes is known to be inherited and to be [illegible] northern Harlem [illegible] equatorial Africa. It is known also that most northern Negroes live in [illegible] and engage in manual or menial labor. One is likely to jump to the conclusion that the economic and social and cultural position of the Negro is also inherited and will continue regardless of education and opportunity. But it is obvious this does not follow from the facts at all.

Difficulties of Race Classification

If we [illegible] to the above error we must then learn to resist the temptation, which is even stronger, to identify individuals with races. Negroes and Nordics and [illegible] different *groups* [illegible] are bound to be [illegible] if we try to place every person that one meets in one of these groups. Perhaps in many instances will be [illegible] assigning persons to the Negro group on the one hand or to the Nordic on the other, but a veritable avalanche of mistakes will [illegible] try to separate Nordics, Alpines and Mediterraneans. And the [illegible] *with all their* measurements are in little better position than the layman [illegible] to which of the Europe[illegible] [illegible] the average [illegible] every will the [illegible] Nordic or Alpine [illegible] [illegible] it is [illegible]

evident if the person whose race we wish to determine responds to the ideal, his traits coincide exactly with the [illegible] for any one race. If we now [illegible] any measure [illegible] for all of the [illegible] we may find [illegible] in the predicament that no actually existing man or woman of any race anywhere conforms to the ideal. Since every individual differs from any other individual, everyone belongs to his own special race. But to say that makes the race concept absurd.

Not only individuals but also whole groups of people are frequently difficult to place in any one race. Our ideas about Nordics come from our acquaintance with Norwegians and Swedes, and our ideas about the Alpines from observations on southern Germans. Now, the inhabitants of northern and central Germany are on the whole intermediate between Nordics and Alpines; among them individuals may be found who are as typical Nordic and as typical Alpine as can be found anywhere. What race do these people belong to? We may try to escape the difficulty by saying that the Nordics and Alpines have [illegible] in their ancestry, [illegible] that they are racial mixtures or hybrids. But a moment's reflection will show that this leads into another difficulty no less serious than the first.

Pure Races?

If you say that something is a mixture, you imply that pure ingredients which have been mixed together either exist somewhere or have existed in the past. But where are the pure Nordics, pure Alpines, pure Mediterraneans, etc.? Wherever you go you will find that only a few inhabitants of any country conform [illegible] the notion of racial purity and uniformity. [illegible] you will meet a lot of tall blond [illegible] persons in the city of Oslo, Norway, but you will find there also many [illegible] with brown eyes [illegible]. There is no [illegible] to indicate that the [illegible] of these Norwegians are any [illegible] to their country than are the blue-eyed blonds. Similarly blue-eyed blonds are met with occasionally among Spaniards, [illegible] who are brunets.

As a last resort, one may suppose that, although no countries inhabited by pure Nordics and pure *Alpines (or by any other pure race for that matter)* exist at present, such countries did exist in the past. This supposition is actually implied in most popular *discussions of the race problem. Back in some distant* Golden Age people zealously kept their race pure and this made them strong and wise. Recently they allowed themselves to become mixed or mongrelized and the twilight of humanity is about to swallow us as a consequence. Such notions are, however, definitely refuted by scientific data. Race mixture has been going *on during the whole of recorded history.* Incontrovertible evidence from studies on fossil human remains shows that even in prehistory, at the very dawn of humanity, mixing of different stocks (at least occasionally) took place. Mankind has always been and still is a mongrel lot.

To be sure, the growth of the world's population in the last two or three hundred years, coupled with the development of the means of travel and communication, has enormously speeded up the process of mixing of the human races. Mixing of at least closely related races (such as those [illegible] in different European countries) appears, however, to be biologically desirable rather than the reverse. A gradual increase of the average stature has been going on in most civilized countries of the world during at least the last hundred years. This becoming taller is due in part to improvement of hygienic conditions and to better nutrition, but in part also to the breakdown of barriers which in the past separated different peoples, so that tall genes could spread more widely. However that may be, nothing can be more certain than that pure races in man never existed and cannot exist.

But suppose that the population of a country, a city, or an island were isolated from any immigrants from the outside and allowed to breed for many generations

with in itself, would not the population eventually become a pure race? Here we come to a matter of [illegible] for the understanding of the whole problem [illegible]. [illegible] pure races could exist only if heredity were like a fluid transmitted through blood, and if the heredity [illegible] of the parents mixed and fused in [illegible]. We know that this [illegible] not happen. [illegible] experiments of Mendel and the calculations of [illegible] and Weinberg showed that heredity is [illegible] particles which can be [illegible] diluted [illegible] particles called genes, so that [illegible] parents [illegible] of the genes [illegible] of [illegible] parents [illegible] brothers [illegible] receive different [illegible]. [illegible] heredity [illegible] the old idea of race [illegible] fallacious as the blood theory.

Suppose that [illegible] with blue eyes and blond [illegible] with dark eyes and [illegible] population. If the hereditary [illegible] to [illegible] individual in this population would eventually [illegible] dark complexion [illegible] the [illegible] colors do [illegible] population descended from Europeans will always [illegible] individuals with dark and light brown and blue eyes and with black, brown, and blond hair. They will [illegible] mixed [illegible] will never become uniform or [illegible] re[illegible].

When a trait such as the skin color in Negroes and [illegible] determined by cooperation of several genes [illegible] seem that the hybrids [illegible] are [illegible] color [illegible] know that this [illegible] not so, because Mendelian [illegible]. Although [illegible] the United States [illegible] New world [illegible]

little more homogeneous than they are at [illegible] certainly nothing resembling complete uniformity will ever be reached. Some anthropologists consider this variable group a race in the making, designated as American Colored.

We can see where the old race notion went astray. It assumed [illegible] or explicitly that a race is a community of blood. If that were so, the racial ideal obtained by averaging the characteristics of a group of peoples who have intermarried for generations would have some meaning [illegible] would approximately correspond to the type which would eventually be reached if the group were to continue intermarrying without any immigration from the outside. The heredity of any individual would be determined by the race from which he [illegible]. Every one of us would be [illegible] a very re[illegible] of our race, [illegible] and bone of our race's bone. The fact is, however, that every group of people consists of individuals who have certain genes in common but differ in other genes. Parents always differ in several and probably in many genes. Their children differ in some genes both from their parents and from each other. The hereditary diversity of a group [illegible] a family, a clan, or a race [illegible] indefinitely. The heredity of an individual is [illegible] partly determined by the race from which he sp[illegible]. The diversity [illegible] variation found within a race is more important than the racial averages.

Definition of Race

[illegible] years [illegible] known [illegible] hundreds, possibly thousands. B[illegible]

of this some of us have blue and others brown eyes, some have prominent and others flat noses, some are tall and others short. Such differences are of course common among people of the same country, state, town, members of a family, and even brothers and sisters. We do not suppose that every person with blue eyes belongs to a different race from everybody with brown eyes. It would be absurd to do so because blue and brown-eyed children are frequently born to the same parents. It happens, however, that certain genes are more frequent among the inhabitants of some countries than of others. Thus blue eyes are very common in most parts of the United States but rather rare in most parts of Mexico. It is this and similar differences which make it possible to say that the inhabitants of the United States are in general racially distinct from the inhabitants of Mexico. Races can be defined as populations which differ in the frequencies of some gene or genes.

Blood Groups

Now let us try to understand the racial subdivision of mankind in the light of this definition. One of the most interesting human genes is that which determines the blood group to which each person belongs. It was of practical importance to work out the inheritance of this gene because of its relation to blood transfusion (the giving of blood from one person to another), so that the distribution of the varieties of this gene amongst the inhabitants of different parts of the world is now pretty well known. Our [illegible] of this whole [illegible] [illegible] by blood transfusion [illegible] experience [illegible] the recip[illegible] [illegible] human groups are [illegible] to the comp[illegible] of their blood. The groups are known as O, A, B and AB. [illegible] transfusion between members of the same group i Blood from people of group O can safely be gi persons of any group, hence group O people are as 'universal donors'. Persons of group AB are versal recipients, since they can safely receive from any other person. But A blood can not be safely to O or B persons, B blood should not be to O or A persons, while AB blood causes troubl transfused into O, A or B persons. To which grou belong can be found out by drawing a drop o blood and mixing it with some drops of blood (the fluid part of the blood from which the cor have been removed) of persons known to be of A and group B. If your blood corpuscles clu gether or 'agglutinate' in B serum, you bel group A; if they clump in A serum, you bel group B; if they clump in both A and B, you to group AB, while if no clumping takes place i serum you belong to group O. The whole exam takes only a few minutes and the clumping is p clear under a microscope or, with practice, it seen with the naked eye.

Genes and Geography

Within the last twenty to thirty years th groups of peoples in all parts of the world ha studied. The most interesting result of these stu been that, with few exceptions, nearly every group examined has been found to consist of a of the 'main' four blood groups. Human races the relative numbers of persons within the [illegible] to each of the four groups. Universal dono O are found in every race and are generally t most common type, group A is also common, while g and especially AB are less common. The table bel [illegible] an idea of the frequency of the blood group ferent parts of the world.

FREQUENCIES (IN PER CENT) OF INDIVIDUALS OF THE FOUR BLOOD GROUPS AMONG THE INHABITANTS OF DIFFERENT COUNTRIES

[illegible]	O	A	B	AB	People	O	A	B	AB
EUROPE					ASIA				
[illegible]	48	4	8	1	Chinese	31	3	28	7
	4	47	9		B[illegible]	32		39	8
[illegible]	4	1	2	[illegible]	Japanese	3	38		1
[illegible]	[illegible]	45		6	[illegible]	37	8	35	
	2	38	2	9	[illegible]	3		37	8
[illegible]	5	31	3	9	[illegible]				
[illegible]les	38	4[illegible]		6	(Bengal)	33		39	8
	31	42	7						
H[illegible]	9	1	6	6	[illegible]				
[illegible]	1	31	7	5	Abo[illegible]	48	5		
G[illegible]	4	4	4	4					
					[illegible]CA				
[illegible]	(		)		Egypti[illegible]	7	39		9
[illegible]	1	[illegible]			E[illegible]	13	7	5	5
[illegible]	9				M[illegible]g	4[illegible]	8		4
[illegible]es	37	3	0	0	[illegible]ygm[illegible]	3	3	9	
[illegible]	8				N[illegible]oes	43	3	9	

If we begin a trip around the world on the Atlantic seaboard of Europe, we find among the English, Portuguese and Spanish populations about [illegible]0 to [illegible]0 per cent of persons of group O, about the [illegible] proportion of group A and about [illegible] [illegible] [illegible] O [illegible] among Russians [illegible] about [illegible] per cent of the population are B and AB. Crossing into Asia we find still higher proportions of B. Africans vary in blood group frequencies about [illegible] Europeans do, while American [illegible] groups differ a good deal among themselves, although [illegible] of them show high frequencies of O, [illegible] of A, and few [illegible] B or AB.

The most important [illegible] we can learn from [illegible] is that the races differ [illegible] blood groups only [illegible]. There are no [illegible] differences [illegible] which [illegible] is all of one blood type and another all of [illegible]. Consider [illegible]. Suppose your blood group O [illegible] and need a [illegible] have offered to donate their blood, whom should you choose as a blood donor? The old and obsolete theory of heredity and the ideas about race based upon it, would counsel you that blood most similar to yours would be found in a person of the same race, and particularly in your close relatives, brothers or sisters. You may also hear that you should choose as blood donor a person of upright character and good disposition, otherwise you may be contaminated by bad blood.

But you had better disregard such advice. If your brother has A, B or AB blood the transfusion would probably be fatal to you because his corpuscles would clump in your blood and clog the small blood vessels. On the other hand, a native of any land who possesses blood of group O will be a better donor regardless of his race or moral qualities. It is wiser to choose your donor according to his blood type, which is determined by his individual heredity, than according to the race from which he sprang. It is this property of his blood that matters, not his skin color, intelligence, or morals. By analogy, if you wish to hear good music it is wise to choose an artist who is a good musician; his blood group does not matter, nor is his skin color relevant. When you vote in a political election the intelligence and honesty of the candidate, not his blood group or musical abilities, are relevant.

The Relativity of Race

The above conclusions sound pretty sweeping. Is it possible that they don't apply to characters [illegible]

[illegible] since genes responsible for other traits show the same kind of distribution over the face of the earth. Take the first human gene difference mentioned in this book, the one which determines whether you can taste phenyl-thio-carbamide or not. This difference has been found in every human population which has been tested, so far as known

every race consists of tasters and nontasters in proportions which are characteristic for the country but differ somewhat from country to country. The same is true of the gene for color blindness, which is found in persons who cannot distinguish red from green. This crops up in every race, albeit with somewhat different frequencies. The same experience is repeated with genes for other blood characters, for various hereditary diseases and for many other conditions.

It l[illegible] though the whole human race had got its [illegible] from the same source. One can [illegible] a huge [illegible] tank in which a great variety of differently [illegible] fish are swimming. There comes an order to [illegible] populate an aquarium in Utah, and the shopkeeper dips his net and brings it up full of flash[illegible] [illegible] gold[illegible] silver[illegible] few black ones, [illegible] and many other kinds in different [illegible]. From this collection there is established [illegible] tion in Salt Lake City pool which may [illegible] be known as the Salt Lake City race. In response to a request from Buenos Aires the net dips in again [illegible] comes up with another collection containing many [illegible] kind[illegible] went to Salt Lake City but [illegible] different proportion, lacking entirely a few [illegible] kinds but containing one or two different ones. Moreover, in Argentina it turns out that the [illegible] naturally [illegible] like [illegible] fish so [illegible] in larger number than the others and the [illegible] samples [illegible] further [illegible] one can recognize that the fish of the Salt Lake City pool and the inhabitants of the [illegible] in Buenos Aires all came from the same source and that many [illegible] colors and kinds [illegible] in each population [illegible] fish [illegible] represent [illegible] from [illegible] ancestor [illegible] our own [illegible] of

[illegible] to follow [illegible] which have be[illegible]

used by anthropologists in characterizing races. A favorite trait of this sort has been head shape. Heads do not vary, as blood types do, in sharply defined alternative categories. The variations are continuous from very long and narrow to very short and broad, with all intermediate shapes, and the differences probably depend not on one or two but on many genes. Heads of all shapes, long, medium and round, occur in all European countries, just as the four blood types appear in all of them, and as in the blood types, the proportions of persons with the different head shapes vary from country to country and from district to district. Roundheads are common in Central Europe—from France through southern Germany and northern Italy to Czechoslovakia, southern Poland, Hungary, Yugoslavia and Albania. The inhabitants of the British Isles, most of Scandinavia and the Baltic provinces of Russia are mostly longheads. Another region of longheadedness is found in the South—Portugal, Spain, southern Italy. Between these regions, in which roundheads or longheads predominate, and also in most of Russia, the population is mostly intermediate in head shape. People with round and with long heads are found also outside of Europe. As examples of roundheads there are Apache Indians in America, Tahitians in the South Seas, and many tribes in Central Asia and in Siberia. Among the longheads are many Eskimos in America, the Australian blackfellows, many Africans and some Indian tribes in Asia.

Now the reason should be apparent why different scientists who attempted to classify mankind emerged with such different collections of races. It is because the genes for different human traits vary quite independently of one another. If we were to classify Europeans according to their blood groups we would probably make a Western race [illegible] English, French, Portuguese and Spanish, who have little blood group B; a Middle race with moderate amount of B; and an Eastern race (Poles, Russians and Finns) in which group B is frequent. According to the shape of the

Instead, we should rather distinguish the Central European race, where roundheads predominate, and two longheaded races—a Northern and a Southern. It is not immediately evident why one of these classifications should be preferred to the other.

Taking mankind as a whole, the usual coloration of the hair is black, of the eyes dark brown, and of the skin more or less brown. It is only in Europe, and particularly across the northern part from England through Scandinavia and northern Germany to most of European R[illegible], that there is a large center of [illegible]. From there the fair-skinned people have in the last few centuries spread all over the world. Southward and eastward from the northern countries the proportions of individuals with blue eyes, blond hair, and fair skin decrease, and of those with brown eyes, *brown or black hair, and swarthy skin increase.* The "Dark Continent," Africa, is of course the world's center of dark pigmentation, although some of the natives of South Africa have again lighter skins. Asia and America are realms of yellow, brown, and "red" skin colors, although in some parts of Asia (southern India) and in Melanesia (New Guinea) the skin colors approach black.

The distribution of stature (height of the body) agrees neither with that of the blood groups nor with that of the head shape or coloration, and we find a still different distribution if we study other physical features, such as [illegible] nose shape or ear form. It is [illegible] clear that the distribution of the genes which determine human racial traits over the earth's surface is very complex, and that different genes vary independently. Where does this leave the problem of the races of man? Well, the attempts to subdivide mankind neatly into several hard and fast racial compartments evidently failed. They were based on false premises—on the [illegible] the "blood" theory of heredity. Th[illegible] recognize [illegible] what [illegible] the better [illegible] to the conclusion that [illegible] not [illegible] races [illegible] precisely that there

are too many different races of too many different kinds.

Races are populations which differ in the relative commonness of some of their genes. If we make a careful study of the populations not only of different countries but even of provinces or districts of the same country, in fact of neighboring villages, we shall almost certainly find them somewhat different. In one village there will be relatively more brunets and in the other more blonds. In one district the universal blood donors will be more frequent than in the other. The populations of these villages or districts are different races by the above definition, but you will never be certain from which village an individual came by merely looking at him or by examining his blood. On the other hand, it is easy to distinguish individuals of Central African *from those of Central European parentage. All sorts of* situations intermediate between these extremes also occur. If a group of people, some of them of Norwegian and others of Italian descent, are present in the same room and you are asked to tell which is which, you will probably guess mostly right, but you will make some mistakes too. In short, when we say that two populations are racially different we are not saying very much. They may be so different that it is possible to tell to which of them any individual belongs, or so similar that only a very careful study by specialists can reveal their distinctness at all.

How Many Races?

In practice scientists and laymen alike try to designate as races only populations the differences between which are large enough to be more or less easily recognizable. Small differences are simply ignored. But difficulties still remain. What may seem a small difference to you may seem large to someone else. As we have seen, some scientists divided mankind into several dozen races, and others into only two. It is quite futile, for example, to discuss whether or not Norwegians and

Italians belong to the same race Races merge into each other geographically If we travel from Norway southward through Germany Switzerland and Italy we find that blue-eyed individuals become gradually less and brown-eyed more frequent But nowhere is there a break or a divide on the two sides of which people are clearly so different that we can say that here the northern race ends and the southern one begins If we make not two but three races a northern a central and a southern the difficulty becomes even greater since instead of one indefinite boundary we have two arbitrary boundaries to contend with

Only rarely can a more or less definite and not quite arbitrary line be drawn between the territories occupied by different races This happens when their territories are separated from each other by some natural obstacle which is a desert or a mountain range which impedes the movement of people from one territory to the other Suppose that we continue our voyage southward from Norway beyond Italy As we cross the Mediterranean Sea the inhabitants of North Africa prove to be rather [illegible] from the Italians although they still belong to the Mediterranean branch of the white race Further southward lies the desert of Sahara the crossing of which used to be a difficult undertaking As a matter of fact it still is difficult except with the aid of an airplane Now as soon as the Sahara is crossed we find people whose skin colors are strikingly darker than those of the people north of the desert We have left the territory of the white race and have arrived in the land of the black race

Unfortunately for those who like cut and dried classifications all the geographical [illegible] of human races are not totally separated by natural barriers such as the Sahara desert Wherever the territories of two or more races come into direct contact populations that are intermediate or that combine the traits of the races in contact are found The longer such contacts last the more widely spread the intermediate populations and the more blurred become racial divisions

Eventually a situation is reached when as in Europe one can recognize anything from a single race to a score or more races

One should not conclude however that because the dividing lines between races are frequently arbitrary races are imaginary entities By looking at a suburban landscape one cannot always be sure where the city begins and the country ends but it does not follow from this that the city exists only in imagination Races exist regardless of whether we can easily define them or not It is a plain fact that most Norwegians can be told apart from most southern Italians by appearance and this is true regardless of whether or not you decide to call them different races Whatever your decision on this score remember that differences between races are compounded from the kind of differences that are found between individuals of the same race A Norwegian may carry some genes and show some physical traits which are typically Italian in the sense that they are more commonly met with in Italian than in Norwegian populations A child born of parents of a given race does not necessarily possess all the traits which are usually met with in representatives of that race The personal qualities of an individual are far more important than the race from which he came

Let us make very sure that we understand clearly why race boundaries are sharp if an obstacle to travel lies between the lands of the races and become indefinite when the races come into contact When people visit each other's homes and countries they learn to know to understand and usually to like each other One of the consequences [illegible] increased frequency of intermarriage In the old days biologists and anthropologists thought it led to a mixture of the bloods of the races and appearance of intermediate or mixed racial groups Although the old blood theory of heredity is wrong the view that intermarriage between races leads to the eventual fusion into a single variable group is correct Suppose that one race has 90 per cent of individuals with blue eyes and 10 per cent with brown eyes

Races of Men and Breeds of Animals

Although putting racial labels on human populations is an arbitrary procedure, it is a fact that the human species is not homogeneous but consists of subdivisions of various orders which differ from each other in the relative commonness of many genes. Biologically these subdivisions are quite analogous to the races or subspecies of animals or plants in nature and to the breeds or varieties of domesticated animals and cultivated plants. All of these arise in the course of evolution through the occurrence of mutations, gene recombination, and natural or artificial selection of those collections of genes which are suited to certain environments.

And yet races of man also have characteristics which distinguish them from races of other animals. Men are subject not only to biological but also to social forces, and these two kinds of influences are in continual interaction with each other.

While races of wild animals and plants are kept apart by geographical separation alone, human races may be separated by cultural barriers. Civilized as well as primitive men have certain rules which govern the choice of mates, and these rules frequently prescribe marital union within a specific group—clan, tribe, nation, religious denomination, economic or social circle. This permits different racial groups to coexist side by side, at least for a time, in the same country.

In the same territory human racial groups may remain relatively distinct, whereas in wild animals and plants which reproduce sexually usually no more than a single race of a species is found in one locality. The castes of India are the most striking example of this. Members of each caste are supposed to and practically always do marry within the caste. Some of the castes [illegible] from racially different peoples who invaded India from beyond its borders at various times [illegible]. Others appear to have separated [illegible]

regation as propounded by partisans of this in the United States is a plan to prevent the flow genes between these races by social means—custom a legislation—instead of by geographical separat Milder forms of social barriers against intermarri of groups of people, such as religious, economic, e cational, and language divisions, may also slow do the gene exchange between populations and postpo for a time the obliteration of the races. But the lon time trend is clearly toward race fusion.

Contrary to the opinion vociferously expressed some sincere but misguided people, such a trend is no biologically dangerous. Mixing of closely related may even lead to increased vigor. As for the most tantly separated races, there is no basis in fact to thin that either biological stimulation or deterioration f lows crossing. The widespread belief that human hybrids are inferior to both of their parents and som how constitutionally unbalanced must be cou among the superstitions.

Do Human Races Differ in Mental Capacity?

Breeds of dogs differ markedly in temperament, responsiveness to particular kinds of training, and he in the uses to which they may best be put by man. Al though almost any dog can be trained when young t be of some use, one would not for choice try to tr a dachshund to be a sheepherder, or a shepherd to hunt rabbits. Similarly the differences in temperament between polo ponies and draft horses, which a certainly conditioned in part by their heredity, fit [illegible] for different functions. These breed differences ha been accentuated by selective breeding by men wh had the different functions in view. It has often be argued by analogy that differences in biological heredit lie at the bottom of intellectual, emotional, and temperamental differences between races and between cultural [illegible] groups.

Another [illegible] runs as follows: Races arise as

part of the evolutionary process by which populations within a species become adapted to a particular environment. Racial variation in skin color has, for example, been viewed in this way. If biological evolution has caused races of man to diverge in physical characters, should it not have done the same for the mental capacities and aptitudes of these peoples?

Both of these arguments by analogy are unconvincing because they are based on a misunderstanding of the nature of biological heredity. It has been pointed out repeatedly in this book that what is inherited is not this or that trait but the manner in which the developing organism responds to its environment. Now the amount as well as the kind of variation which a trait shows in different environments is decided by the hereditary make-up of the organism. For example, individuals who carry the genes for the O, A, or B blood groups have the respective blood groups regardless of their state of health, the climate they live in, or the nutrition which they receive. The blood group is rigidly fixed by heredity. But the skin color is not so rigidly fixed, since it changes rather rapidly depending on the exposure of the skin to sunlight. Finally, whether or not an individual gets into conflicts with the law depends upon the person's upbringing and circumstances, and also upon the kind of laws which the society sees fit to establish. Human behavior is then quite plastic and can be changed by the living conditions.

The important problem is why some traits are more and others less fixed, or rather, the fixity or plasticity of a trait is a matter of evolutionary adaptation. By and large, the traits which are important for the survival [illegible] which a species or a race [illegible] all the environments [illegible] fixed [illegible] the development of the [illegible] external stimuli [illegible]

But it is also advantageous for the safety of the organism to have some traits change rather easily when the environment changes. For example, dark skin pigmentation is advantageous during summer vacation on the seashore. But little skin pigment is supposedly advantageous to secure a supply of vitamin D (the "sunlight vitamin") when sunlight is scarce. The genetic constitution which is most favorable in a changeable climate is then one which permits the development of darker or lighter skin colors at different seasons and in different climates.

The relative fixity of the temperamental make-up of horse or dog breeds is then understandable. These breeds have been fashioned by man and intended for different uses. A great Dane with the temper of a fox terrier might be dangerous, and a fox terrier with the temperament of a great Dane would be boring. The genetic component is important in the temperament of these breeds. It has been made important by selection and breeding. But has there been a similar selection in the evolution of man?

It is plain that different social positions and different trades call for somewhat different behavior patterns. The qualities most useful in a military leader are not the same which are most favored in a writer or a scientist, and vice versa. The mentality of a nomadic hunter is usually different from that of a farmer. But the pre-eminent requirement of living in any human society is very nearly always the same: it is the ability to learn from experience and to adjust one's behavior to the needs and circumstances. This requirement is fundamental for living in any culture or civilization from the most primitive to the most complex. Accordingly, the process of selection which has been, and still is, most powerful and persistent in human evolution is that for the ability to learn new ways of behavior, new techniques of doing things, and new skills.

In short, the human species as a whole has developed away from genetic specialization and fixity of behavior and toward educability. This is true for all races of

man and for all climates. Therein lies the most important biological feature of the evolutionary pattern of mankind. Breeds of dogs or of horses have been deliberately fashioned for performance of different services by making their genes different. Man is certainly capable of pursuing a great variety of ways of life. But he is enabled to do so by different training and education, not by acquiring different genes. This does not mean that the genetic differences among men do not affect their temperament and ability. But from the vantage point of evolutionary biology we can see that such differences are not fundamental. Far more important is the fact that human capacities are developed by training from childhood on. Pathological cases aside, human personality is shaped mainly by the patterns of interpersonal relations which prevail in a given culture and by the individual experiences of each member of a community. This genetically conditioned educability has guaranteed the success of mankind as a biological species and has in turn permitted progressively more advanced cultural development.

C[illegible] Pe[illegible]

Although universal uniformity of men appeals to some people, there is no reason why monotonous sameness should be our goal. On the contrary, such a prospect appears bleak in the extreme. Psychological and cultural differences among individuals and groups furnish the leaven of creative effort which carries mankind toward ever greater achievements. The question whether or not human races differ in hereditary psychological traits for the time being must be regarded [illegible] open. We know that a variety of different civilizations [illegible] existed and exist in the world. The differences [illegible] cannot be accounted for [illegible] between them [illegible] between the groups of [illegible] [illegible] [illegible] between the social [illegible] by the cultural [illegible]

ferences to an extent assuredly greater th be influenced by biological heredity. Furth the differences between individuals are cer greater than the average differences betw races.

We have seen that the psychic trait whic and still is most favored in human evol ability to profit from experience, the educa educability does not make all men alike opposite is true. The survival advantage of to learn and to be trained consists precisely development of a person can be turned in many possible directions as necessity may de capability permits, then a vastly greater dive man personalities than could possibly aris mentality were genetically fixed as it i in the inhabitants of the anthill. Far fro mental uniformity, human evolution has le ing diversity.

Regardless of how the problem of the r tween biological heredity and individual and chology and culture may eventually b variety of human cultures will appear to u ing rather than a curse if we learn to understand and to admire them. In the real there is enough room to accommodate th contributions not only of different individ of every nation and race. It is a waste of which particular contributions are s which inferior. There is no common measur the works of a poet, an artist, a philosop tist, and the simple kindness of heart of a Humanity needs them all.

Appendix

Why Do the Proportions of Dominant and Recessive Genes in a Population Remain Constant from Generation to Generation?

SUPPOSE THAT a previously uninhabited island or other unoccupied land [illegible] of land populated by a group of immigrants among whom there are as many individuals who can [illegible] as those who can not taste the PTC [illegible]. The ability to taste PTC is, as we know, [illegible] gene *T*, [illegible] inability to taste it to the [illegible]. Suppose that the tasters are all pure (homozygous) for the gene *T* (*TT*). This gene *T* for tasting is dominant to that for non-tasting, *t*, and the non-tasters are all pure for that gene (*tt*). What proportions of tasters and non-tasters will be found in the population of the island in the next and in all following generations? Since it does not matter for people whether or not they can or can not taste PTC, and in fact very few people know to which of these two categories they belong, the ability or inability to taste this [illegible] they [illegible] affect the [illegible] choices among the [illegible]. In other words the chances that a taster will marry [illegible] taster or a non-taster will be determined simply by the proportions of the tasters and non-tasters among the eligible mates. If so the married people and their progenies will be about as follows

MAR[illegible]			Child[illegible]
M[illegible]	W[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	*TT* ([illegible])
[illegible]	[illegible]	[illegible]	*Tt* ([illegible])
[illegible]	[illegible]	[illegible]	*tt* ([illegible])

Of the men who are tasters about half will marry tasters and half non-tasters; of the men who are non-tasters about half will marry tasters and half non-tasters. This means that of all marriages about ¼ [illegible] both tasters, about ½ are mixed marriages, and about ¼ both partners are non-tasters. If tasters [illegible] non-tasters live about equally long and have about [illegible] same number of children, the first generation of children will consist of ¼ pure tasters *TT*, ½ [illegible] tasters *Tt* and ¼ pure non-tasters *tt*, or in other [illegible] about 75 per cent tasters and 25 per cent non-[illegible]

Now we want to know what kind of children [illegible] children will have if marriages amongst them [illegible] place at random with respect to the ability to [illegible] PTC. In this case there will be three kinds of [illegible] (*TT*, *Tt* and *tt*) and the same three kinds of wo[illegible] the proportion ¼, ½, ¼. The possible combinations [illegible] husbands and wives and the children expected [illegible] these marriages, if four children are born from [illegible] marriage, will be as follows

Men	Wives	[illegible]	Children	
¼ *TT*	¼ *TT*	1/16	4 *TT*	
¼ *TT*	½ *Tt*	2/16	4 *TT*	4 *Tt*
¼ *TT*	¼ *tt*	1/16		4 *Tt*
½ *Tt*	¼ *TT*	2/16	4 *TT*	4 *Tt*
½ *Tt*	½ *Tt*	4/16	4 *TT*	8 *Tt*
Tt	¼ *tt*	2/16		4 *Tt*
¼ *tt*	¼ *TT*	1/16		4 *Tt*
tt	½ *Tt*	2/16		4 *Tt*
¼ *tt*	½ *tt*	1/16		
		Totals	16 *TT*	32 *Tt*

The children will again appear in the pro[illegible] ¼ *TT*, ½ *Tt*, ¼ *tt*. There will have been no change [illegible] of [illegible] non-tasters. They will [illegible] as they were among the p

The same conclusion can be reached in a di[illegible] way. Instead of considering the random mating [illegible] the members of the population we can think

genes which are transmitted through eggs and sperm as constituting a great pool from which two genes, one from the mother and one from the father, are drawn whenever a new individual is formed. In the original mixture there were equal numbers of T and t genes. When these are drawn out two at a time, we find that two T's are drawn about once every four draws, two t's also once in four times, while a T and t appear twice in each four draws. So we come again to the conclusion that the first generation will consist of [illegible] per cent TT (pure tasters), 50 per cent Tt (hybrid tasters), and [illegible] per cent tt (nontasters).

What will the second, third and later generations of the islanders be like? Consider again the pool of genes in the sex cells which will give rise to the next generation. The pure tasters TT will have [illegible] cells, each with T; the [illegible] will give [illegible] cells, each with t. The hybrid tasters (Tt) will [illegible] 100 cells, 50 of them with T and [illegible] with t. The total pool will have 100 T and 100 t, [illegible] of the two kinds of genes just the same as the pool from which the first generation [illegible]. This [illegible] that the second generation, like the first, will consist of

25 per cent TT	}	tasters
50 per cent Tt	}	
25 per cent tt		nontasters

All the following generations will be like the first [illegible] if the [illegible] cent [illegible] about [illegible] numbers of T and t sex cells. The proportions [illegible] in the first generation [illegible] people marry [illegible] their [illegible] to taste PTC [illegible] gene T will neither crowd out the [illegible] The proportions of the two kinds of genes remains constant. They [illegible] equal.

[illegible] just half tasters and half nontasters [illegible] special case but it is not difficult to prove

that the proportions of a pair of genes will remain constant regardless of what the proportion is. Suppose for example that the original pool consisted of 90 per cent T and 10 per cent t sex cells. If $\frac{9}{10}$ of the sex cells have T and $\frac{1}{10}$ have t, then when we draw them out two at a time each T will have nine chances of meeting a T and one chance of meeting a t; each t will also have nine chances of meeting a T to one chance of meeting a t. Therefore 81 per cent (9 times 9) of all combinations, hence of all people arising from such fertilized eggs, will have two T genes, 18 per cent (9 times 1 taken twice) will have a T and a t, and one per cent (one times one) will have two t genes. The generation arising from such random mating will therefore consist of

81 per cent TT	}	tasters
18 per cent Tt	}	
1 per cent tt		nontasters

If each of these [illegible] contributes two genes to the pool from which the genes of the next generation will be drawn, the pure tasters will contribute 162 T sex cells, the hybrid tasters 18 T and 18 t sex cells and the nontasters 2 t sex cells. The totals are 180 T and 20 t or a ratio of 90 per cent T to 10 per cent t. Since this is the same as the original proportion, the second and all following generations will continue to have 99 per cent of tasters and 1 per cent of nontasters.

The proportions of the genes will remain constant indefinitely regardless of what their original proportions may be. [illegible] who are not afraid of first year algebra [illegible] the proof of this statement. Suppose that a fraction q of the sex cells of the original settlers carry the gene T, and a fraction (1-q) the gene t. The first generation [illegible] will then consist of $q^2 TT + 2q(1-q) Tt + (1-q)^2 tt = 1$. The pool of sex cells of the next generation will contain $q^2 + q(1-q) = q$ cells with T and $q(1-q) + (1-q)^2 = (1-q)$ cells with t. Obviously the relative frequencies of T and t remain constant [illegible] the proportions of tasters and nontasters in the United States 70 per cent to 30 per cent we can

der e a value of $(1-q) = 0$ $(1\ q) = 17$ $q = 4.9$ that is the American pool of genes consists of about 1 per cent T and 1 per cent t and this remains constant generation after generation provided no immigrants with different proportions of T and t enter to disturb the gene frequency and that mutation does not favor either T or t.

Any other pair of genes will behave in the same way as T and t provided the population is large and there is random mating. This allows us to predict what will happen in human populations.

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